Standards, soil, science and policy

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Standards, soil, science and policy

Labelling usable knowledge for soil quality standards in the Netherlands 1971-2000

VRIJE UNIVERSITEIT

Standards, soil, science and policy

Labelling usable knowledge for soil quality standards in the Netherlands 1971-2000

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad Doctor aan
de Vrije Universiteit Amsterdam,
op gezag van de rector magnificus
prof.dr. L.M. Bouter,
in het openbaar te verdedigen
ten overstaan van de promotiecommissie
van de faculteit der Aard- en Levenswetenschappen
op vrijdag 27 oktober 2006 om 13.45 uur
in het auditorium van de universiteit,
De Boelelaan 1105

door

Astrid Felicie Mathieu Maria Souren

geboren te Schimmert

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A mind that is stretched to a new idea never returns to its original dimension

Oliver Wendell Holmes sr. (1809-1894)

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Voorwoord

Het proefschrift heeft tot onderwerp de selectie van bruikbare kennis voor bodemkwaliteitsnormen in Nederland tussen 1971 en 2000. Het proefschrift is ook een tussenstadium in de ontwikkeling van een interdisciplinaire wetenschapper. Dat blijkt tussen de regels, uit de structuur van het proefschrift, en uit de samenstelling van de literatuurlijst.

Groen. Zonder ingewijd te zijn in het vakgebied begon ik destijds aan een verkenning van de verschillende disciplinaire benaderingen die ik zou kunnen gebruiken in mijn onderzoek. Ik had practische werkervaring, nationaal en internationaal, op het snijvlak van wetenschap en beleid, maar een theoretische basis had ik niet; die wilde ik juist komen opdoen. Niet gehinderd door historie of door de schoolvorming binnen de sociale wetenschappen doorkruiste ik in de eerste jaren van het onderzoek de bestuurskunde, de beleidswetenschappen en het wetenschapsonderzoek. Op zoek naar een benadering waarmee ik in het onderzoek aan de slag wilde. Als disciplinair opgeleid natuurwetenschapper op ontdekkingstocht in de sociale wetenschappen, genieten! Ik had geen aanknopingspunten. Ik kende de ongeschreven wetten niet, ik kende de relevante wetenschappelijke tijdschriften niet, ik kende de namen niet van de grote mannen en vrouwen en hun theoretische en methodologische uitgangspunten. Ik kocht syllabi van vakken die me relevant leken. Ik leende de sociologische klassiekers in de bibliotheek. Ik heb ze toen geen van allen gelezen. Wat moest er worden van de ontwikkeling van mijn sociaal wetenschappelijk perspectief?

De kentering kwam toen ik ‘The structure of scientific revolutions’ las. Thomas Kuhn geeft daarin zijn visie op de ontwikkeling van wetenschappelijke paradigma’s die zo belangrijk zijn voor disciplinevorming in de wetenschap. De herkenbare beschrijving en de overtuigende stijl waarmee Kuhn zijn visie naast die van anderen positioneerde, maakte indruk. Niet langer was de werkelijkheid eenduidig. Het waren interpretaties, waarvan er meerderen naast elkaar konden bestaan. Niet één maar meerdere perspectieven op de werkelijkheid waren mogelijk. Het perspectief van de natuurwetenschapper, waarin alleen de objectief waarneembare werkelijkheid bestaat, voldeed niet langer. De kiem van de sociaalwetenschapper in mij was nu echt gelegd. Het natuurwetenschappelijk perspectief behield evengoed haar aantrekkingskracht en eenvoud; ik zou het nooit overboord zetten. Sindsdien werd mijn ontdekkingstocht gekenmerkt door mijn wens om de aantrekkingskracht van het sociaal constructivisme te paren aan de eenvoud van het meer essentialistisch en realistisch natuurwetenschappelijk perspectief waarin ik was gesocialiseerd. Zo werd de ontwikkeling van het interpretatief kader voor het onderzoek het vehikel voor mijn vorming tot interdisciplinair wetenschapper.

Wat nu bekend is over interdisciplinaire vorming plaatst mijn grillige en voor velen onnavolgbare zoektocht in een ander licht. Interdisciplinaire vorming begint niet met het bestuderen van de klassiekers, het eindigt er mischien wel mee. Het begint met het zoeken naar een aansluiting tussen de nieuwe discipline en de gekende. Niet verwonderlijk dus dat ik alleen las wat aansloot bij mijn kennis en dat een boek als dat van Kuhn bruggen kon slaan. Dat kenmerk van interdisciplinair leren wordt wel omschreven als 'jumping the tussocks'. Net als wandelen in het hoogveen vereist interdisciplinaire vorming dat er hoge en droge, veilige plekken zijn. Veel later ben ik Kuhn opnieuw gaan lezen, om de wetenschapsfilosofische, -historische en -sociologische betekenis te begrijpen. Toen werd Kuhn een van de klassiekers en zo komt ook in dit proefschrift iets van de laatste fase in de vorming tot interdisciplinair wetenschapper in beeld: 'the real beginning'.

CHAPTER 1

Standards for soil quality

1.1 On standards

When asked 'What is a standard to you?' these are typical answers from the respondents interviewed during my research:

> It is a guideline issued by government to restrict activities. The process preceding the issuing, i.e. the development process of the guideline is also part of it. What are these restrictions, and what are the figures in the guideline? This is all part of the standard.

> To me, standards are maximum acceptable concentrations set up by government.

> A standard can comprise of a broad variety of aspects. A standard gets meaning through the (policy context) in which it is embedded. What are the implications of exceeding a standard?

Typical about the responses is the variety of meanings attached to standards. To some, a standard is only a number, whereas to others the standard includes the development process and the context in which the standard will be implemented. Is a standard a figure, a manifestation, or a materialisation of policy objectives? What a standard *is*, i.e., how it appears and is manifested, differs enormously. Apparently, what a standard *is*, is not standardised. Illustrative of the diversity encountered when taking standards as a subject of research is that my supervisors independently of each other suggested different 'definitions' of a standard. It was then that I was certain, that any attempt to 'define' it, would not be worthwhile.

For this thesis, I have studied the recent history of the development of soil quality standards in the Netherlands between 1971 and 2000. The different perspectives, especially those from science and policy, on what standards are, what they represent and what this means to the development of new standards are equally important in this research. Standards for soil quality are typically determined in an ongoing interaction between stakeholders, such as science, policy, local governments, and industry. The exact height of such standards is therefore the outcome of an interaction in which different interests prevail. The interaction of these interests is decisive for the outcome of the standards. Standards for soil quality distinguish between 'polluted soil' and 'clean soil', and all possible categories in between. This is important to note, as this distinction has different meanings and different consequences in the economic, social and ecological realms. With every new set of standards, the classification of soil qualities changed. Theoretically, the same pile of soil labelled 'clean' today may be labelled 'polluted' tomorrow. Standards appear as concentration levels of substances in the soil. For example: the reference value for copper ([Cu]) is 36 mg per kilogram dry soil. Apparently, soil with a copper concentration of 35 mg per kg dry soil differs from soil containing 37 mg per kilogram dry soil. Not so much in terms of their physical qualities, but in terms of their qualification: above versus below the standard. The concentration level as such is not informative about the reasons for the demarcation it produces. The meaning of a standard, i.e., the reason for this demarcation, is concealed behind the figure of 36 mg per kg. Why is soil with [Cu] of 35 different from soil with [Cu] of 37? This is a relevant question, as the implications of this demarcation are significant.

The implications and stakes associated with the demarcation produced by a standard are significant. Researching soil quality standards immediately implies a study into the meaning and associated stakes concealed behind the concentration levels.

A handful of soil does not readily appear 'clean' or 'polluted', but gets such a label on the basis of experimental research and debate about what is meant by 'clean' and 'polluted'. Classification and standardisation are social processes, while they appear to be scientific constructs, i.e., they are materialised as scientific constructs. In other words, standards embody social constructs, while their appearance suggests that the distinction between clean and polluted is scientifically 'determined'.

This hybrid character makes standards an interesting subject to study. To understand this hybrid character one needs to be familiar with both the physical and social aspects of standards. Much more is concealed behind a standard than any disciplinary approach can ever unveil. This thesis represents an interdisciplinary study that draws attention to and exposes the hybrid character of soil quality standards.

The change in soil quality standards announced by the Cabinet in June 1997 was the third revision of the standards for soil quality in the Netherlands since 1980. That year, the discovery of severely polluted soil in a newly built suburb (Lekkerkerk) caused an enormous public outrage among the home-owners, fearing for the values of their houses, their health and the health of their children. When a number of barrels leaking chemical waste, such as benzene and ethyl benzene was discovered, it was decided to treat the whole suburb, evacuating all inhabitants, and removing the polluted soil. The inhabitants lived at an improvised campsite (Benzenidorm) for weeks. The Dutch Queen, who had only just been inaugurated, visited the area and further increased the media hype about Lekkerkerk (Van de Griendt and Janssen 2004).

Figure 1.1 Treatment of polluted soil in Lekkerkerk, 1980 (Van den Brink et al. 1985 p. 16).

Through public arousal and media attention, soil pollution suddenly became the prime political issue in the summer of 1980, with the Minister of Public Health and the Environment and the Prime Minister appearing regularly on TV for further explications of the situation and the measures taken. To a large extent, the public arousal legitimated the drastic measures taken, but ultimately, the comparison of the actual soil quality with the standards provided the legitimation of the drastic and expensive measures, because the concentrations of benzene and ethyl benzene found in the samples exceeded the then current standards. In retrospect, 25 years later the measures taken in Lekkerkerk were evaluated by comparing the then measured concentrations with the latest standards (Otte and Lijzen 2004) revealing that adequate measures had been taken at the time, according to the latest standards. The discovery and cleanup of the Lekkerkerk suburb speeded up the development of the legal framework for foil protection (Soil Protection Act (Min.VROM 1987), Interim Soil Pollution Act (Min.VROM 1982)). However, more important to the research described here, is that Lekkerkerk was the impetus for the development of standards. Not only to assess potentially polluted sites, but also to determine target levels for treatment schemes at polluted sites. Illustrative of this is the publication of soil quality standards in the Interim Soil Pollution Act published in 1982.

Table 1.1 The first standards for soil quality (the ABC values) published in the Interim Soil Pollution Act (Min. VROM 1982). This table gives ABC values for soil and sediment. The first column lists the metals. The A values served as a reference for clean soil. The B values represented concentrations above which further research was required to assess the toxicity of the pollution. The C values represented concentrations above which toxicity was beyond doubt, but further research was required to identify the appropriate treatment measures.

	A Value	B Value	C Value
Cr	100	250	800
Ni	50	100	500
Cu	50	100	500
Zn	200	500	3000
Cd	1	5	20
Hg	0.5	2	10
Pb	50	150	600
As	20	30	50

The publication of these soil quality standards in the above-mentioned Interim Act illustrated the importance that was being attached to such policy instruments. Usually, standards are not published in Acts as it is very difficult and time-consuming to change formulations laid down in Acts, making policy relatively inflexible. This is why all later soil quality standards were published in separate policy plans, and never in Acts. In every assessment of potentially polluted sites the standards were used as references. The impact and costs associated with assessments and treatments of polluted sites are high. Standards provided the legitimation of expensive and large-scale remediation operations. Any modifications to such standards therefore have an extensive effect. Such changes require years of work in terms of scientific experimentation and modeling, translating scientific finds into new concentration levels of substances. In addition, as argued above, standards are social constructs, and revising standards for environmental quality can only be successful if this change is related to the social context in which these standards are developed, negotiated, set and implemented. This thesis sheds light on the work involved in changing the standards for soil quality between 1971 and 2000.

Table1.2 lists the successive standards for soil quality published since 1982. The ABC values were explained in the caption of Table 1.1. The reference values were developed as operationalisations of the guiding principle of soil policy and represented clean soil, as defined in the Soil Protection Act. Compared to the A values, the reference values also served as references. Whether or not the reference values are stricter compared to the A values depends on the soil type. This relation is explained in detail in Chapters 4 and 5. The reference values were developed in a process that involved more scientific input and advice compared to the development of the ABC values. Target values succeeded the A values (and thereby the reference values) and intervention values succeeded the C values. Target and intervention values are based on scientifically derived concentration values calculated with Species Sensitivity Distributions. The details of these scientific and policy approaches are given in Chapters 4 and 6. The height of the reference values and the A values for heavy metals is the same, although their meaning is different. The intervention values are much stricter or (almost) equal compared to the C values (see Table 6.3 for a comparison). Soil remediation objectives (SROs) have been developed as parts of the soil policy renewal. These SROs are function-based. That means that different soil quality standards apply to different land uses, while the previous standards applied irrespective to land use. Therefore, a comparison of the height of SROs and the other standards requires a more detailed understanding of these different standards.

Table 1.2 Succession of standards for soil quality in the Netherlands 1982-1999. The second column provides the year of publication, the third column gives the years in which the standards were developed.

Generic standards for soil quality	Published in	Development process
ABC values	1982	1982
Reference values	1988	1979 -1988
Target and intervention values	1994	1985 –1994
Soil remediation objectives	1999	1992 –1999

At first glance, it looks as if standards were developed nicely one after the other; new standards following up previous ones. However, a closer look at the table reveals that the development of the successive standards overlaps considerably; while the reference values where published in 1988 (Min.VROM 1988), the development of the second set of standards (target and intervention values) was already ongoing (that development can be traced back to 1985 (Kooijman 1985b)). In between the publication of standards, scientists and policymakers were involved in a complex interaction resulting in the selection of the scientific models to calculate the height of the standards. While studying this interaction, it seemed that this is exactly where the key is to the robustness and acceptance of these environmental policy instruments: the close co-operation between science and policy. This is in line with seminal work done by Jasanoff on standards for environmental quality in the US (Jasanoff 1990). The complex interaction between individual scientists and policymakers and the variety of committees and working groups surrounding the standard setting process provide the checks and balances and the acceptance of the agreed standards. The role of scientists in this process takes on different forms. It will be illustrated that a similar working practice can be found on soil quality standards in the Netherlands. Sometimes this co-production appears as joint actions, with scientists and policymakers operating side by side, whereas at other times, science and policy are explicitly stated to be separate domains, each with its own norms. The complexity of the interactions and the importance of these interactions to the success of the standards are concealed by the list of concentration levels published in policy documents.

1.2 Standards conceal meaning

Standards conceal several meanings. Standards appear as concentration levels of substances in the soil. For example: the reference value for copper ([Cu]) is 36 mg per kilogram dry soil. Apparently, soil with a copper concentration of 35 mg per kg dry soil differs from soil containing 37 mg per kilogram dry soil. Not so much in terms of their physical qualities, but in terms of their qualification: above versus below the standard. The concentration level as such is not informative about the reasons for the demarcation it produces. The meaning of a standard, i.e., the reason for this demarcation, is concealed behind the figure of 36 mg per kg. Why is soil with [Cu] of 35 different from soil with [Cu] of 37? This is a relevant question, as the implications of this demarcation are significant. For instance in the case of Lekkerkerk, if measured concentrations at a specific spot exceeded a certain concentration level, it meant that that spot had to be cleaned at high costs. The implications and stakes associated with the demarcation produced by a standard are significant but concealed behind the concentration level.

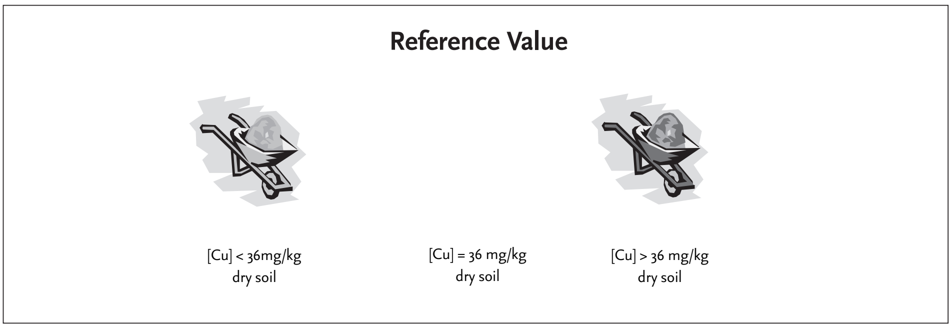


Figure 1.2 The reference value for copper ([Cu]) is 36 mg/kg dry soil.

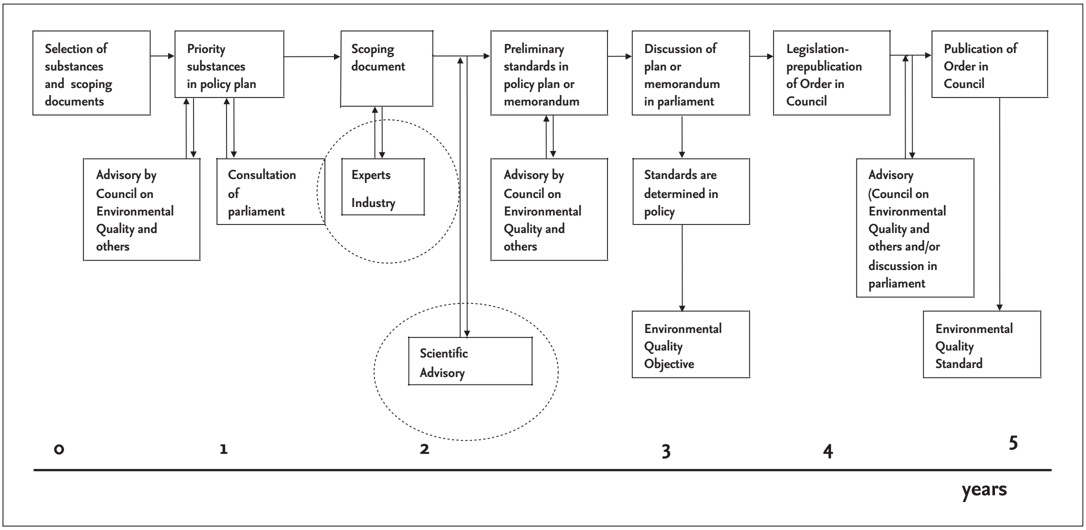
From the above it seems there are two aspects concealed. First, the interaction between science and policy is concealed. Second, the meaning and associated stakes attached to the exact height of the standard are concealed. As pointed out already, this thesis sheds light on this first aspect: the interaction between science and policy. Standards reflect both the scientific knowledge available or judged relevant and the aims of soil policy.

1.3 Standards between science and policy

The production of standards for soil quality is often represented as a complex process involving (amongst other parties) science and policy. Two examples of such representations are given below. They are typical for at least three distinct reasons. First the process is depicyted as a linear sequence of decisions and assessments. Second, it is suggested that the development of standards takes place in isolation from other policy, societal or scientific developments. The development of standards is depicted as a process, driven only by an internal dynamic of decisions, assessments and documents by the successive actors in the process. Third, loops and feedback mechanisms are lacking. Typical for such representations is that science and policy have distinct tasks and responsibilities and are represented as different domains. According to this representation, policymakers formulate standards, either to operationalise policy objectives or to set policy priorities. Initially, standards are formulated in qualitative terms, and through the production process they are translated into quantitative standards, based on scientific knowledge that is finally evaluated by policymakers. The first example is from about the development of target and intervention values (Ragas and Leuven 1993). The second example is about a report by the Health Council (1995) on the development of integrated environmental quality objectives.

Such representations of standard setting practice have been questioned by different authors following increasing criticism on quantitative standards, and more precisely on the assumed objectivity of quantitative standards. In science and policy studies earlier work has been done on the development of standards and on the roles that science and policy play in this production process. Notably studies by Jasanoff (1986, 1989, 1990), Bal and Halffman (Bal 1998; Bal and Halffman 1998; Halffman 2003), and Bowker and Star (2000, 2001) have enriched our understanding. These studies include comparative analyses of standard setting practices in various countries (US, UK, the Netherlands) and in various policy fields (health, toxic substances, water quality standards). These authors provide further indication of the inadequacy of the formal representation by uncovering that considerable effort is invested to connecting daily practice to this formally representation of distinct involvement by science and policy. This 'repair work' (Bal 1998) has become part of daily work for scientists and policymakers involved in standard setting. Albeit differences between the studies on standard setting, they all reveal the inadequacy of the representation of standard development processes as described above. Science and policy do not operate as distinct and well-demarcated domains.

a



b

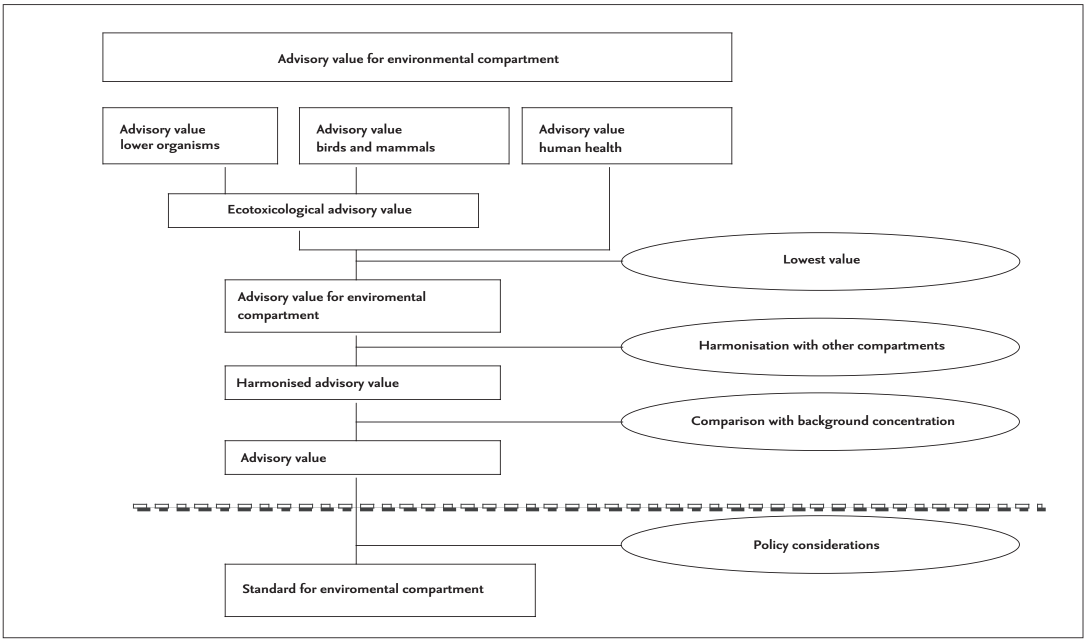


Figure 1.3 Two examples of the formal representation of the procedure to derive standards. a) procedure to derive target and intervention values. Encircled is scientific advice (Ragas and Leuven 1993). b) procedure to derive integrated environmental quality objectives. Above the dashed line is the scientific underpinning, below the dashed line the policy process to set the standards (Gezondheidsraad 1995).

These studies have denoted instead that there is significant interaction and co-operation involved in the production of standards. Also, boundaries are blurred, contested, and demarcated continuously. Complex interactions between science and policy have developed and have been institutionalised to facilitate or even enable this interaction. Jasanoff contends that it is exactly the partial integration of science and policy in procedures, discourses and interactions that explains the relative success of standards as policy instruments. The outcome of that work is relevant to the policy field and the standards studied in this thesis. In previous work on this it was revealed that the formal representation of a separate domain of science and policy is not adequate as a representation of actual practice. Organisations involved in developing standards for soil quality cannot be assigned the label 'science' or 'policy' unambiguously (Souren 2000; Souren et al. 2000), For instance, in the advice about the standards for zinc, the Health Council took the implementation of policy into account and did not restrict itself to the scientific knowledge available (Van Straalen and Souren 2002). In a broader context, Van Eijndhoven and Groenewegen convincingly showed that (scientific) experts adopt different strategies during their involvement in assessments of standards for substances (Van Eijndhoven and Groenewegen 1991). In practice, science and policy are not as distinct as sometimes suggested in formal representations. That is the starting point of the work described in this thesis.

This thesis provides further empirical evidence about the inadequacy of the formal representation of standard setting as a representation of actual practices; the blurring of the boundaries between science and policy is obvious in the different cases. Furthermore, this thesis contributes to a line of research in science and policy studies in which we speak of a co-production of science and policy on instruments involving technical and scientific knowledge. Typical of co-production processes is that the location of boundaries between domains – here science and policy – is subject to debate. These debates play a boundary-demarcating role, and have been typified by Gieryn as boundary work (Gieryn 1995, 1999). Based on her research into environmental standard setting in the US, Jasanoff states that the creation of such boundaries of scientific expertise seems crucial to the political acceptability of advice' (Jasanoff 1990 p. 236). Jasanoff further states that the political success of what she calls 'boundary work' increases when agencies and advisers are involved in negotiating the location and meaning of the boundaries. The boundary work metaphor does pertain inasmuch to boundary demarcation (and not only to boundary blurring).

Chapter 3 reviews three bodies of literature. From the discussion in that chapter it becomes clear that what is problematic about the metaphors of boundaries, boundary work and co-production, is that they still bear witness to a distinction between 'a policy' and 'a science' domain. Illustrative is the distinction between 'regulatory policy' and 'regulatory science'. Such distinctions are empirically difficult to maintain; where does regulatory policy stop and regulatory science begin? Boundary work metaphors have stretched the boundary line to a boundary zone, but it seems difficult to replace the labels of science and policy by meaningful new labels that do justice to the practices at the overlap. As science and policy have moved beyond the meet and merge stage, this thesis refers to such practices as 'regulatory practice' and explores this practice. Characteristic of such practice is that scientists and policy-makers involved in producing standards have increasingly developed a common ground that has taken them beyond the stage of meet and merge. This common ground provides stability, meaning and significance to social behaviour. In regulatory practices, usable knowledge to calculate the standards is labelled in a complex interaction between science and policy. In this thesis usable knowledge is the knowledge that used to calculate the concentration levels that later become the standards. What exactly was usable knowledge was identified in retrospect. Not until the standards were set, it could be established what body of knowledge was used. It is that specific body of knowledge that is referred to in this thesis by 'usable knowledge'.

As mentioned already, the concept of boundary work increased our understanding of the development of standards. However, it appeared to be insufficient for understanding how regulatory practices operate and interact within an institutional and organisational context. This shortcoming has been identified by Gieryn (1999) and was transformed into the challenge for this thesis. For the interpretative framework, the boundary work metaphor was complemented with insights from institutional theory, notably the concept of institutional context as developed by Scott (1995, 2001). Including an institutional concept in the interpretative framework insight is expected to increase in how regulatory practices operate and interact within an institutional and organisational context.

The formal representation of the production process of standards is proposed to be complemented by a representation reflecting actual practice (see Figure 1.4). This figure shows that development of standards takes place in a practice at the overlap between science and policy. As we will see throughout the thesis, boundary debates abound in such practices. For instance in Chapter 6, we will see how research science becomes distinguished from regulatory science during the development of the target and intervention values (the left boundary of the overlapping area in Figure 1.4). In the third case study, where the development of soil remediation objectives is analysed, the boundary between regulatory policy and regulatory science (the right boundary of the overlapping area) is demarcated.

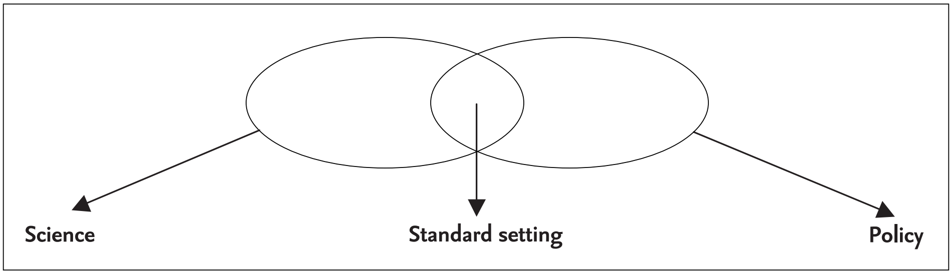


Figure 1.4 Standard setting at the overlap of science and policy.

1.4 Guiding question

In the first section of this chapter the successive production processes of standards for soil quality in the Netherlands were identified as the object of this research. One of the characteristics of these standards is that the socially constructed nature of 'clean' and 'polluted' is concealed behind the standards in the form of concentration levels (see Section 1.2). The meaning remains invisible until standards are exceeded: fauna and flora are exposed to high concentrations with the risk of suffering from adverse effects, human health might be adversely affected, and, often at high costs, soil is treated with an impact on economic and social activities. The approach in this study is unfolded in Section 1.3. Standards are produced in a regulatory practice that is developing at the overlap of science and policy where extensive boundary work takes place. For a better understanding of regulatory practices, the labelling of usable knowledge for soil quality standards in these practices is studied in more detail. The arguments used while labelling usable knowledge are expected to be related to the institutional context within which regulatory practices develop and exist. This provides the legitimation for labelling. The question that has guided the research described in this thesis can now be formulated as follows:

> *How can we understand the labelling of usable knowledge for the development of soil quality standards in terms of boundary work between science and policy and in terms of the relation between regulatory practice and its institutional context?*

This guiding question will be further explored in Chapters 2 and 3. This results in the formulation of five research questions at the end of that chapter. In the empirical heart of the thesis, three case studies are presented (Chapters 5, 6, 7) where regulatory practice in operation is analysed. These case studies are related to Chapter 4, where the institutional context is described. The case chapters identify the arguments used in labelling usable knowledge. These arguments are related to the dimensions of the institutional context that is described in Chapter 4. Overviews of the development of environmental policy fields usually distinguish stages or episodes on the basis of preselected criteria (see for example (Van Tatenhove and Leroy 2000) and this thesis will do just that as well. This research setup shows how the arguments applied in labelling are related to the institutional context.

The question above has guided the development of an interpretative framework and the collection and selection of empirical material. Before explaining the interpretative framework in more detail in Chapter 3, methodological choices are explained in Chapter 2. The research questions are formulated at the end of Chapter 3.

CHAPTER 2

Methodological choices

Chapter 1 concluded with the guiding question of the research. Chapter 2 discusses the methodological choices made during the research, i.e., how empirical material was collected and analysed and how the case studies were selected and related to their context.

My knowledge about the developments in policy and in ecotoxicology was based on my MSc. in Biology and my work for the Advisory Council for Research on Nature and the Environment (RMNO)[1] as a secretary of the working group preparing a new policy-relevant research programme in ecotoxicology (Commissie Systeemgericht Ecotoxicologisch Onderzoek RMNO 1996). This knowledge provided a provisional understanding of the labelling of usable knowledge for soil quality standards in the Netherlands. Based on such provisional understanding of the practice of standard setting, I constructed an interpretative framework and matched it with the case studies. With the analysis of three intensive case studies and their context, my factual understanding of this process of labelling usable knowledge increased, transforming my provisional understanding into firmly grounded, 'evidence-based' understanding (see Figure 2.2 for a visualisation).

2.1 Contextual analysis as research strategy

The case study methodology stood out from the start. Several methodology papers and textbooks provide definitions of case studies. The definition formulated by Eisenhardt points out the adequacy of case studies for my research, as it illustrates that cases are embedded in a setting.

1 Since 2000, the Advisory council has expanded its scope and since then includes Spatial Planning.

> The case study is a research strategy which focuses on understanding the dynamics present within single settings
> (Eisenhardt 1989)

Eisenhardt suggests with her definition that case studies are adequate to reveal dynamics present within a setting. This setting (or context) is portrayed as relatively stable, while the case study is typically a dynamic picture. The difference between 'stable' and 'dynamic' is a gradual one, of course, but such difference certainly applies to the case studies and the institutional context in which they are embedded. The case studies in this thesis focus on the labelling of usable knowledge for specific soil quality standards; a dynamic process involving a number of actors in regulatory practice. The context for regulatory practice is the solidified practice as it is institutionalised, written down in extensive and various policy documents and plans, and sedimented in research programmes and organisations.

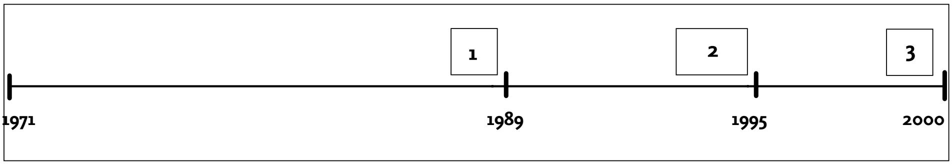


Figure 2.1 Episodes and case studies on a time line. 1) reference values (Chapter 5); 2) target and intervention values (Chapter 6); 3) soil remediation objectives (Chapter 7). 1977-1988: episode 1; 1989-1994: episode 2; 1995-1999: episode 3.

The three case studies in this thesis shed light on the labelling of usable knowledge for the subsequent soil quality standards. The first case study is about the development of the reference values and is embedded in a context characterised by the start of soil policy, the development of a research infrastructure concerning soil protection and the institutionalisation of the interaction between science and policy. The second case study concerns the development of the target and intervention values and is embedded in a context characterised by an increasing number of participating actors and within which a reflection takes place on the course of soil policy. Also new concepts are developed and exchanged between science and policy (for instance and most clearly: the risk approach). The third case study is about the development of the soil remediation objectives and is embedded in a context where new steering concepts for policy and science are developed. Figure 2.1 shows that the case studies are positioned within a context that is subdivided into three episodes. Each case study is treated in a separate chapter, while the context, the long-term development of soil policy and research, is described and interpreted in another chapter (Chapter 4). This setup allows single case analysis as well as a contextual analysis, where case studies are related to the development in the episodes. This contextual analysis is typical for the approach in this thesis. With this approach the dynamic developments within each case study can be studied in detail and case studies can be compared. In addition, such a research strategy enables to establish a connection between case studies and context (or setting as in the definition by Eisenhardt). In Figure 2.1 the context is subdivided into three episodes; episode 1 between 1971 and 1988, episode 2 between 1989 and 1994, and episode 3 between 1995 and 2000. This distinction of three episodes is based on an analysis of this context while applying the concept of institutional context. This concept was already introduced in the previous chapter and will be further discussed in Chapter 3.

The three case studies are intensive case studies as defined by Barton Cunningham.

> Intensive case study principles suggest that researchers develop an understanding of real settings and then search for a range of explanations or interpretations. They offer an environment to search for variables to describe a theory and to conceptualise the constructs to understand it. (Barton Cunningham 1997 p. 401)

The empirical material is drawn from the field of soil policy and involves the labelling of usable knowledge to calculate soil quality standards. From this empirical field a set of case studies was selected and discussed with experts. Based on the expert opinions, the final selection of the case studies was made. The following criteria applied to the case study selection.

- *The set of case studies must be qualitatively representative*
- *Each additional case study must enrich, not replicate*
- *Each case study must be substantive enough to stand on its own and allow for a cross case comparison*
- *Cases must be well-documented*

These criteria have led to a selection of three intensive case studies. Each case study is embedded in a context or setting to which Eisenhardt refers in her definition above. The three case studies represent the standard setting in the given time period, simply because there are no other generic standards for soil quality developed in soil protection policy that have a generic character and that have been developed in a close and visible interaction between science and policy. The only other case study that might have been included was the development of the ABC values in 1982 (see Chapter 1 and 4 for an explanation of these standards). However, informants (see Section 2.3.3) advised against this case study, as it was unclear and undocumented how these standards were derived. Another suggestion for case study selection was to analyse the development of substance-specific standards, for instance to analyse standard settings for zinc. The second criterion of the above four made clear that the development of one substance-specific standard should not be included as replication would abound then.

The case studies each reveal a different aspect of boundary work in the labelling of usable knowledge between science and policy. This made single case analyses possible, but also allowed cross-case comparison (third criterion). The development of the three respective frameworks for soil quality standards was sufficiently well documented for analysis (fourth criterion). As contextual analysis was at the core of the research strategy, the selection of cases studies implied the demarcation of the context. That context was defined as the institutionalised development of soil policy and science and demarcated by its relevance for the development of soil quality standards. In other words, the demarcation of the context followed from the case study selection. To allow for contextual analysis of each of the case studies, I searched and found demarcating events or developments in this context that were related to the case studies.

Now, the set-up of the research consisting of case studies and episodes is complete and as follows. The first episode starts in 1971 and ends in 1988. The first case study, pertaining to labelling usable knowledge for the reference values, is embedded in this episode and demarcated between 1986 and 1988. The second episode starts in 1989 and ends in 1994. In this second episode, the second case study, pertaining to labelling usable knowledge for target and intervention values, is studied. This case study is demarcated between 1991 and 1994. The third episode is the shortest; it starts in 1995 and ends in 2000. The third case study pertains to labelling usable knowledge for soil remediation objectives and is demarcated between 1997 and 1999. Conclusions are drawn for each separate case study. In addition, the case studies are compared to draw attention to developments on labelling usable knowledge throughout the period analysed in this research. The length of the episodes and case studies differs. The cases are located towards the end of the episode. While the episodes get shorter, the cases are comparable and all span two to three years. The three episodes, which provide the setting for the case studies, are characterised and described in Chapter 4. The basis for demarcation of the case studies and of the episodes is discussed in Section 2.2.

2.2 Issues of Demarcation

2.2.1 *Methodological demarcation*

In the research I adopted an interpretative research approach. For an understanding of what is meant by this, the following quote from Alvesson and Sköldberg on interpretation is helpful.

> Interpretation implies that there are no self-evident, simple or unambiguous rules or procedures, and that crucial ingredients are the researcher's judgement, intuition, ability to 'see and point

something out', as well as the consideration of a more or less explicit dialogue – with the research subject, with aspects of the researcher herself that are not entrenched behind a research position, and with the reader.
(Alvesson and Sköldberg 2000 p.248)

As explained above, the guiding question of the thesis was based on my provisional understanding of the empirical field and theoretical concepts. With that provisional understanding, more empirical material on the recent history of standard setting for soil quality was interpreted, thereby transforming it into understanding, and directing the further development of the theoretical perspective. In an iterative mode, provisional understanding, through reading and pondering about possible interpretations of the empirical material became understanding. In the same vein, the interpretative framework gradually developed from a confrontation of theoretical perspectives with empirical material, searching for insightful interpretations of the empirical material. Such a cycle, in which the researcher moves back and forth between understanding and provisional understanding has been described as a hermeneutic cycle (see (Alvesson and Sköldberg 2000) for an elaborate description of reflexive research approaches and their relation to hermeneutic and critical research approaches).

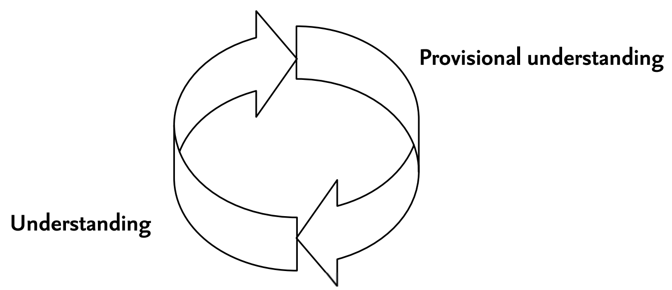


Figure 2.2 The first hermeneutic cycle. After (Alvesson and Sköldberg 2000).

Besides this cyclic process, a second cyclic process is at the heart of interpretative methodology. The second hermeneutic cycle represents the relation between the part (case study) and the whole (context). These units of analysis are different and in their interaction they create and increase each other's meaning and significance. In this thesis, as explained above, this contextual analysis stood out.

Looking at contextual analysis from a methodological perspective makes clear that the case studies must be understood as studies in which a magnifying glass is used to look at the 'production' of context. Through the labelling of usable knowl-

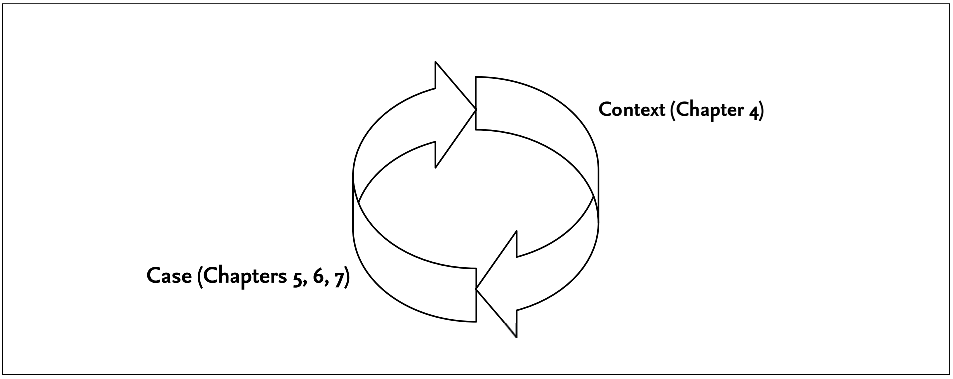


Figure 2.3 The second hermeneutic cycle. After (Alvesson and Sköldberg 2000) and as described by, e.g., Gadamer (1975) and Bernstein (1983).

edge in regulatory practice institutionalisation takes place, thereby producing a context within which standards are developed and implemented. It is the interplay between these two units of analysis (case study and context) that form the heart of the methodological approach in this thesis. The interpretative framework must contain a perspective for the interpretation of the cases study, for the interpretation of the context and for the connection between the two. At the case study level, regulatory practice is at work. At the context level, institutional context is at work. The labelling of usable knowledge and especially the arguments used in labelling connect the two. Arguments are used in regulatory practice, but provide legitimacy for labelling only because they are embedded in the institutional context. By looking at this interplay between case study and context, meaning is given to the empirical material under scrutiny in the case study and in the context study.

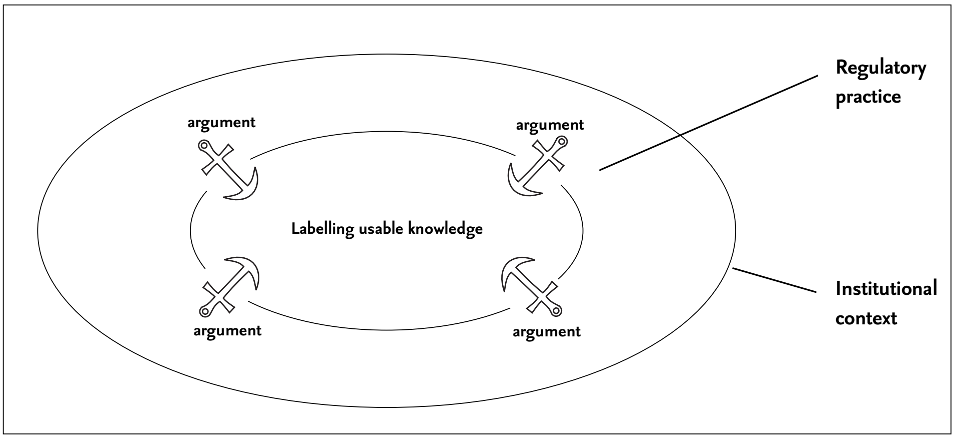


Figure 2.4 Visualisation of the relation between context (institutional context, Chapter 4) and cases (regulatory practice, Chapters 5, 6, 7). The inner, smallest ellipse represents regulatory practice. In regulatory practice usable knowledge is labelled. The arguments used for this labelling connect and anchor regulatory practice to the institutional context; the outer ellipse.

2.2.2 Empirical demarcation

Besides the methodological demarcations, several empirical demarcations were made in this research. Some of these will be explained in the empirical chapters, when they relate to the specificity of the case studies, as this is most convenient for the reader. Here generic demarcations are given.

First, the empirical material studied spanned the years between 1971 and 2000. The first date refers to the installation of the Ministry of Public Health and the Environment and the first step in the development of a legal framework for soil policy (see Chapter 4). The end of the studied time span is determined for practical reasons, which coincided with the publication of the results of the soil remediation objectives shortly before (BEVER regiegroep 1999).

Second, the research was restricted to the standards developed within the framework of protective soil policy; in other words, the standards developed to inform policy about the size of the soil pollution problem, to determine the urgency and priority for clean-up, and to direct future policy. The development of these standards was transparent and well-documented. The main reason for this demarcation was that these standards were developed in interaction between academic science and policy (at the national level). However, with time, the role of industry and of other government levels increased (see for instance the analysis of the development of standards for zinc (Van Straalen and Souren 2002) in which industry has played a decisive role). Likewise, I chose not to focus on soil quality standards used as targets for clean-up as these standards are embedded in a setting in which a variety of actors and interests in a public-private cooperation, thus inhibiting a focus on the interaction between science and policy.

Third, I restricted the analysis to the development of standards. I did not look at implementation of standards as instruments to decide about the remediation at individual sites. Science is mostly involved in standards development and not with that implementation. Implementation was implicitly included in the sense that implementation problems are channelled back into the development process of subsequent standards. These empirical demarcations were the consequence of my focus on the interaction between science and policy.

Fourth, focus was on the development of the frameworks for generic standards for soil quality, instead of zooming in on a specific substance, on a group of substances or on a specific polluted site. Although there are certainly advantages of studying such specific standards, it would have made it much more difficult to compare developments within the policy subsystem through time. In addition such selection would imply an in-depth analysis of all actors involved in standards for that specific substance, as well as an in-depth analysis of available (scientific) knowledge on that specific substance or group of substances. In summary, the case studies were demarcated on theoretical and methodological grounds (Glaser and Strauss

1967; Huberman and Miles 2002). The final chapter provides a reflection on the demarcations made during the research.

2.3 Research methods

The data presented in this thesis were collected by document analysis, an archive search, interviews and participation at meetings and symposia.

2.3.1 Document analysis

Relevant documents concerning the empirical material were found through literature searches, through advice and recommendations by respondents and an archive search. Mainly, these documents were policy plans, reports by the Health Council, the Technical Committee on Soil Protection (TCSP) and several working groups established between 1971 and 2000 for advice on scientific and policy matters. The more abstract and general the reports were, the more they served the analysis of the context (Chapter 4). Especially policy plans and final reports of advisory committees were used for this purpose. More specific documents, i.e., research and conference papers, letters, memos, final reports of the Health Council and TCSP were analysed in search of argumentation used for the labelling of usable knowledge. The empirical chapters and Chapter 3 contain quotes from documents to illustrate how the arguments appeared in documents.

2.3.2 Archive search

The semi-static archives of the Ministry of Public Housing, Spatial Planning and the Environment (VROM) in The Hague were consulted to obtain more detailed information on the labelling processes in the respective case studies. For some aspects of the context chapter (notably, the development of the legal framework), the semi-static archives provided details that helped to sharpen my interpretation. Before each visit I demarcated the subjects to study, and selected the relevant folders from the documentation from the Archives. Studying archive material of the different case studies revealed the different communication strategies through the years. This posed a problem in terms of comparing the research material for the different case studies. In the 1970s and 1980s, people mostly corresponded through written memos. Meanwhile, the importance of e-mail and telephone has increased. These sources leave hardly any traces in archives. In the empirical chapters, quotes are used from archive material to illustrate how arguments were made, but also to revive the chapter by bringing 'the evidence' in.

2.3.3 Interviews

At the start of the research eight informants were interviewed[2] to develop an understanding of the field and of the issues these informants considered interesting to study. For the case studies and the context, 14 respondents[3] were interviewed. These respondents were affiliated to policy and science. All interviews were semi-structured and lasted between 1.5 to 3 hours. Respondents were selected based on their role in the case study and based on suggestions from previous respondents. This snowball method would have implied an imbalance in the number of interviews for the respective case studies, as the number of actors involved expanded vastly. For my final case study, the number of interviews was restricted, this was compensated by the discussions I had had at meetings and workshops[3]. This difference in approach was possible and adequate as the last case study was still ongoing during part of the research. The first and second cases were already closed at the time.

The first group of respondents was knowledgeable on one case study. In other words, the group consisted of case-specific respondents that had played a role in one (or more) of the cases. The interview questions focused on that role, and on the perceived interaction between science and policy. These interviews were geared towards a reconstruction of the course of events, and involved factual questions about events, reports, meetings, contacts. In addition, the respondent was invited to reflect on the position of the particular case within the broader context of soil policy and standard setting. The second group of respondents consisted of generalists: respondents that were not involved in one case in particular, but who had an overview of the standard setting for soil quality either from a side line, or through involvement in more than one case. With these respondents the interviews served to check and fine-tune the interpretative framework, the context chapter and cross-case analysis. All interviews were taped and transcribed. Quotes are used to illustrate the appearance of arguments and the complexity of the practice of standard setting.

2.4 Any recommendations?

As explained in the first and second section, an interpretative research approach has been adhered to. I have attempted to stay close to the empirical material, and take a modest position concerning normative judgements about the course of events in

2 See Appendix 1 for a list of interviewed persons and informants.

3 Bodembreed; National Symposium for Soil policy and research 1998, 1999, 2000 NARIP meeting 1998 at the RIVM Bilthoven, VVM bodemcafé; Netherlands Association of Environmental Professionals soil cafés Utrecht, Wageningen, The Hague between 1997 and 2004.

Chapter 4 and the arguments used for labelling in Chapters 5, 6 and 7. Such a research approach does not combine with a normative judgement of what happened, and of how the field should proceed. This does not mean that the researcher is invisible, nor is it suggested that the empirical material is presented without interpretation. On the contrary, any researcher selects and interprets empirical material at several moments during the research. That is at the heart of qualitative and especially interpretative research approaches. I have attempted to avoid to judge these events and the arguments applied in labelling. Of course, keeping track of developments and changes, and having read the critical reports, I developed a view on the ongoing development. Although in a strict sense there may not be any impetus to impose a normative judgement, in my view it is not befitting for two reasons. First, an interpretative approach aims at giving the floor to the actors, positioning the researcher at the side-line of ongoing developments in the policy field, qualified to reflect on the course of events. Imposing a normative judgement reduces all this careful work by putting on top of it a normative judgement by the researcher. It assumes an out-of-place authority of the researcher. A modest position should be taken by researchers, without regarding the views developed during the work as irrelevant. The value of this analysis is found in the reflection on the course of events, i.e., on the patterns emerging. Second, recommendations assume that results from the research described here are generalisable and pertain to future developments. That is not true. Interpretative inquiries pertain to the empirical material that is studied only (Huberman and Miles 2002). Trustworthy analyses of cases can produce insight that can be used for future development, but any suggestion of generalisability to future developments is out of place. Therefore, recommendations about how to proceed will not be provided. I will, however, give my opinion about a number of issues, as issues for discussion among the actors involved in developing standards in regulatory practices. In my view, this does justice to the actors who have to 'paddle their own canoe', and to interpretative approaches.

CHAPTER 3

Interpretative framework

Chapter 3 presents the interpretative framework as it is applied to the empirical material. The chapter starts with a review of literature in Section 3.1. Section 3.2 presents the interpretative framework developed during the research. It is presented here in its final version, instead of showing its development as this would complicate the argumentation in this thesis.

The interpetative framework consists of four related concepts: 'boundary work', 'labelling usable knowledge', 'regulatory practice' and 'institutional context'. Each of these will be briefly introduced here before moving on to the literature review.

As explained in Chapter 1, my perspective is that standards development involves both science and policy and requires boundary work between the two. This interaction is complex for obvious reasons; both domains have their own interests, their own time frame, their own language, and their own strategy to communicate. In the development of standards the boundary between science and policy sometimes disappears, but sometimes it becomes subject of intense debate instead. Boundaries demarcate, drawing distinct lines, excluding and including issues and actors. At the same time, boundaries evoke debates about their exact position and the possibilities to penetrate, blur or remove boundaries. In some cases, it is the boundary between science and policy that is discussed, while in other cases it is the boundary between different types of scientific knowledge that is under scrutiny. The concept of boundary work draws attention to the fact that in interactions, science and policy (or research science and regulatory science) are constantly aware of and concerned about these boundaries. Boundary work can be observed in regulatory practices. When scientists and policymakers engage in the labelling of usable knowledge, the boundaries between science and policy are at stake. This labelling process is important in regulatory practices; the concentration levels that are calculated as scientific grounds for the soil quality standards define the size and type of the problem of soil pollution and they play a crucial role in defining the meaning of concepts like soil, clean, polluted, adverse effect, risk, etc. Related to these cognitive concepts are the relations between involved stakeholders. These relations also play a deciding role in defining, the meaning of these concepts. Labelling is a significant process that largely determines the concepts used in setting quality standards.

This thesis is based on the assumption that the arguments applied in the labelling process ultimately grant legitimacy to the regulatory practice. Regulatory practice is to be understood as the relatively dynamic and not (yet) institutionalised context within which regulatory issues such as the determination of standards for environmental quality are settled. Eventually, regulatory practices might get institutionalised. Regulatory practices are 'made up' of actors and individuals that share a common interest in regulatory issues. These actors can be affiliated to organisations that are associated with science or policy or both. In a similar vein, the arguments used for labelling can be scientific, policy-related or a mixture of both. The arguments applied in labelling usable knowledge must be embedded or anchored in the institutional context. The institutional context is solidified regulatory practice, stabilised and of wider reach than the development of standards.

Institutional contexts can be described, understood and analysed in different ways, depending on one's perspective. The interpretative framework is based on an institutional perspective in which institutional context is made up of three dimensions (regulatory, normative and cognitive dimension). Arguments applied in labelling must be related to the institutional context in order to legitimise regulatory practice and the standards produced.

The approach is explained with the help of a figure repeated from Chapter 1. Figure 3.1 gives an example of a representation of the involvement of science and policy in the procedure of standard setting. Encircled are the steps in the procedure where scientists and/or experts are involved. The figure illustrates the complexity of the development of standards in terms of the steps to be taken and the number of involved actors. At the same time, the figure suggests a simplicity in terms of the distinction between science and policy. All steps are demarcated and the responsibilities of the different actors are connected to distinct parts of the process. The first encircled step shows that the input from experts results in a distinct product: the scoping document (Basisdocument). This might suggest that a scoping document is scientific. That is not true; for instance it is the policymakers who decide about the format of the scoping document (the arrow from the left). After the scoping document is put together, scientific advice (second encircled step) is organised. At this stage in the development process, scientists are actively involved in what has been coined as *trans-science* by Weinberg as early as 1972 (Weinberg 1972). After Weinberg, several authors have developed more precise concepts to refer to this boundary spanning work by scientists, but Weinberg's first stroke stands firmly. The scheme is illustrative of the formal representation of these procedures. Such

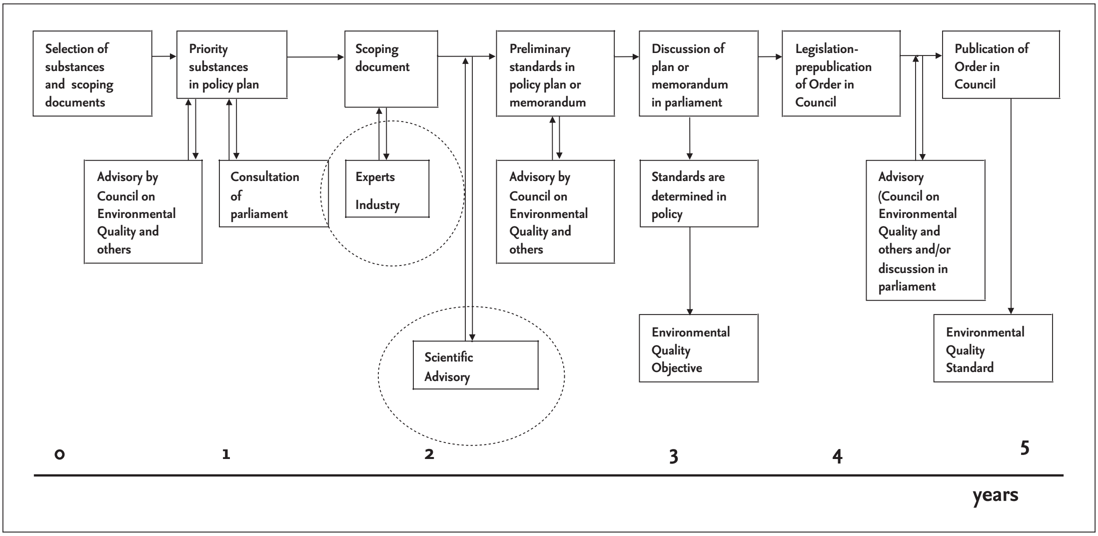


Figure 3.1 Procedure to derive target and intervention values. Encircled is scientific advice (Ragas and Leuven 1993).

representation seems to explain the distribution of the different tasks and responsibilities; it does not represent actual practice as will be shown throughout the thesis and as was argued in Chapter 1. The scheme conceals the complex process in which scientists and policymakers engage and reduces this complex process to a flow diagram, with single pointing arrows. In practice and at the level of the individual scientists (or practitioner) the demarcation between science and policy is less clear. An excerpt from an interview with a member of a committee that assessed the scientific quality of the research carried out for the production of target and intervention values (second case study) illustrates this. The respondent reflects on his role and says:

> In scientific discussion you bring in policy arguments to keep the group on the track of applications, and not let the discussion get bogged down in what is scientifically at stake. Conversely, in policy working groups, you bring in more scientific issues.
> (Quote, in Van Langen (2001))

That is what scientists and policymakers do in processes of developing standards; they manoeuvre, sometimes spanning boundaries, sometimes demarcating boundaries between science and policy. In his thesis on the development of standards, Bal (1998) has uncovered the discursive work being done by regulatory practitioners to connect practice to such formal representations that often serve as political and administrative legitimation afterwards. In other words, practitioners (be they scientists or policymakers) are engaged in repair work. The practice of developing standards is about deciding about the boundaries between (parts of) science and policy.

In her work on regulatory science and standard setting in the US Jasanoff (1990) exposes boundary work by EPA (Environmental Protection Agency). In her analysis she reveals that regulatory science and advisory work is as much a matter of negotiation (between science and policy) as of boundary work (in the sense of clearly demarcating the boundaries between the two). In general, the demarcation of the boundaries grants political legitimacy. However, Jasanoff describes cases where legitimacy stemmed from the joint involvement of science and policy in explicitly negotiating and determining the location and meaning of the boundaries (Jasanoff 1990 p. 236). Whether the blurring or the demarcation of the boundaries is the most successful strategy depends on the specific type of problem under concern. This touches on the relation between boundary work and the structure of problems (see, for instance, (Turnhout 2003)).

In order to provide a context and background to the approach, a literature review is presented in this thesis, which discusses three themes of research in science and policy studies on boundary work. Together, these themes make it clear that boundary work is multi-faceted; it concerns both the social and the cognitive aspects of the relation between science and policy. The strength of the concept of boundary work is that it gave, and still gives, the floor to the actual 'work' that is being done by actors involved while negotiating (including blurring as well as demarcating) the boundaries between formally distinct but related domains. According to Gieryn, the author who laid the groundwork and empirical proof for this concept, future research into boundary work should, amongst other issues, also concern the question: In what organizational or institutional arenas does the boundary-work occur? (Gieryn 1999 p.29). In the upcoming section literature is brought together to explain different perspectives on boundary work, which were used during the research. This literature has inspired the interpretation of the cases and is used in Chapter 4 upto and including 7. In relation to the issues identified by Gieryn as important for further research, I developed an interpretative framework with related research questions in the second part of this chapter, where the interpretative framework is explained.

3.1 A literature review

The literature review in this section discusses the themes of research that have contributed to the development of the interpretative framework presented in full in Section 3.2. The different themes discuss the aspects of the relation between science and policy that affect, and in turn are affected by, boundary work.

The first theme is discussed in Section 3.1.1 and concerns the social structure of the science-policy relation. This section starts by discussing the 'two communities' metaphor that distinguished science and policy as two distinct domains. Gradually, this focus on the difference between domains faded and was replaced by concepts focusing on commonalities between domains. Obviously, it is the awareness of sharedness that triggers boundary work; as long as two domains are distinct, there is no need to engage in discussions about the exact location of boundaries. Reversely, boundary work also 'produces' sharedness. This part of the literature review makes it clear that the recognition of a shared ground, a commonality between science and policy is crucial to boundary work.

Section 3.1.2 deals with the second theme and discusses literature about the changed status of (scientific) knowledge. Boundary work and the status of scientific knowledge relative to other types of knowledge are related. With boundary work, the authority of scientific knowledge over other types of knowledge as legitimate grounds for decisions and policy has become the subject of debate. Reversely, it could be argued that boundary work is exemplary for the decreased authority of scientific knowledge. There is no cause-effect chain connecting boundary work and the levelling out of the exclusiveness of scientific knowledge compared to other types of knowledge (notably local and tacit knowledge).

Section 3.1.3 discusses the third theme and brings together literature about observed or required changes in the locus of knowledge production. A crucial notion in this literature is that the complexity of the societal problems at stake calls for new 'arrangements' and new types of problem-solving strategies and knowledge production (transdisciplinary knowledge, post-normal science). A related concept about the knowledge infrastructure is the concept of Mode II, that is based on (according to the authors) observed shifts in the mode of knowledge production.

From this review it appears that boundary work as a concept has many facets. Not all of these are carved out as precisely as needed to increase the analytical strength of the concept. The review shows what facets of the concept are best carved out. Ultimately, the review identifies the background for Gieryn's plea to set out on an analysis of the organisational and institutional context.

An undercurrent in the literature reviewed in this section is the epistemological development in science and policy studies. Undoubtedly, changes in knowledge production as described by Gibbons and co-authors (1994) actually take place, and can be observed. In the case studies, we will indeed see that the structure of research programmes changed in line with the changes described by these authors. However, the epistemological development in science and technology studies and in policy studies interacts with these empirical observations. Science and policy studies have come to focus on actual practice rather than on ideal type or rationalist representations of the science-policy relation and the scientific and policy domain. The tendency to look at the actual work being done by scientists, policymakers and members of regulatory practice determines to some extent the shifts described in these literature reviews.

3.1.1 From two communities to boundary work

An influential metaphor of two communities was developed by Caplan (1979), drawing on the Rede lecture by Snow in 1959 (Snow 1959). Caplan used the two communities' metaphor to distinguish science from policy and to discuss their inherent differences. In this perspective of two separate domains, science was characterised by its interest-free quest for truth, while policy was characterised as driven by the promotion of self-interest (Albæk 1995). According to Caplan, science and policy differed by conforming to different rules of the game, and by producing either an objective, uncontested, truth (science) or a subjective and normatively inspired policy. Science and policy in this metaphor were two distinct and separate communities with little in common. Science could be distinguished by institutionalised norms to which scientists adhered. Merton identified a set of institutionalised norms that distinguished science (**C**ommunalism (the injunction to share findings promptly), **U**niversalism (the idea that ideas should be evaluated according to impersonal criteria), **D**isinterestedness (scientists should avoid 'eclipsing rivals through illicit means' and **O**rganised **S**cepticism (scientists should weigh evidence in a considered manner), abbreviated as CUDOS) (Merton 1973)). Based on these norms, scientific practice could be evaluated and assessed. The internalised norms would effectively produce certified knowledge. The separate communities of science and policy were connected by knowledge being produced by the scientific community and feeding into the policy process and needed by politicians. Major concern in this view was to bridge the gap between science and policy and to determine the most effective and efficient way to transfer knowledge from science to policy. This perspective has inspired the development of knowledge transfer projects in science and policy. It has led to a body of work in science and policy studies concerned with knowledge transfer summarised in Section 3.1.2.

The two communities metaphor began to lose ground when case studies revealed day to day practice in science. Mitroff and Sagasti (1973) identified norms governing actual work by scientists that are counter to the CUDOS norms as described by Merton (counter norms). The Mertonian norms and Mittroff's counter norms pointed at aspects that mattered in scientific practice. By using the norms in this way, they became less prescriptive, but rather indicative of aspects of science that are identified in essentialists' attempts to define why science is distinct from other practices (Gieryn 1995; Yearley 2005). Mulkay formulated additional criticism on the Mertonian norms by pointing at the fact that these norms were used strategically, and not instrumentally. Mertonian norms were applied to differentiate between good science and bad science in a strategic way, but were according to Mulkay of limited value in governing scientists' daily work. Laboratory studies later on added weight to the constructivist criticism on essentialists' perspectives like the Mertonian norms. These studies revealed the constructed nature of scientific facts

(Knorr-Cetina and Mulkay 1983; Latour 1987) that challenged the adequacy of the CUDOS norms to describe scientific practice. These observations led to criticism on the 'two communities' metaphor, questioning the adequacy of distinguishing the domains as separate, and consequently questioning the adequacy of the linear model in which knowledge was flowing from science into policy.

> Science and policy are not as fundamentally different identities…What counts as knowledge in a given research community is based on a negotiated reality in exactly the same way as the object of politics. There is no science without interest, and no politics without analytical reflection.
> (Albæk 1995 p. 96)

In addition, studies into the application of scientific findings in political controversies (Jasanoff 1990) made it clear that scientists who have a much wider span of control than the laboratory bench are still identified as scientists. Criticism on the identification of norms as adequate descriptions of science which had led Gieryn to contend that the cognitive authority that distinguishes scientific practice from other practices was probably not so much grounded in internally accepted norms, but rather on external norms (see also (Yearley 2005) for an overview of this debate on external-internal norms). Gieryn shifted focus from internal to external characteristics as determinants of what constitutes science. He also encouraged shifting focus from the internally accepted norms towards accounts of actual scientific practice. Gieryn argued that the epistemic authority of science was shaped downstream and not upstream at the laboratory bench or in reviewing manuscripts (Gieryn 1999 p. 27).

In her work on standard setting for chemical substances in the US and the role of scientists as advisors, Jasanoff (1990) showed that scientists actively engage in boundary work in standard setting practice. She argued that boundary work was crucial to the success and implementation of standards. In her later work, Jasanoff made a distinction between scientific practice and policy, but she stressed that the common interest in a specific subject might be a more intriguing and promising explanation for boundary work than their (pretended or perceived) different rationalities. Based on these findings, Jasanoff and Wynne coined the concept of co-production and defined it as:

> In this model of co-production, scientific knowledge and political order are co-produced at multiple stages in their joint evolution, from the stabilization of specialized factual findings in laboratories and field studies to the national and international acceptance of causal explanations offered by science and their use in decision-making.
> (Jasanoff and Wynne 1998, p. 6)

The work by Jasanoff and Gieryn is exemplary of a body of literature that focused on the position of science in a societal context and in relation to societal problems. In his thesis, Halffman (2003) discussed this conceptual work further. He explained the dualism in boundary work (demarcation one the one hand, and boundary spanning on the other). He argued that both are existent and important. He also pointed out the dualism in science studies about boundary work, where some authors are inclined to discuss these issues with a 'cage model' in mind, whereas others discuss boundary work with a 'seamless web model in mind'. His plea is to actually look at what is being done and to identify when and why demarcation abounds and when and why boundaries are spanned. In his thesis, he exposed the regulatory regimes on pesticides, discharges and chemical substances in the US, the UK and the Netherlands. He argued to take a close look at how boundaries of science and policy are institutionalised or materialised in **t**exts, **o**bjects and **p**eople (TOP approach). Boundary work could then be interpreted as the work involved in producing TOP.

The boundary metaphor gave rise to the development of concepts emphasising the merger of science and policy and the commonality of the daily work done in these domains. The conceptual development is either deductively or inductively accompanied by case studies, such as the work by (Bal 1998; Boogerd et al. 1997; Broekhans 2003; Guston 2001; Huijs 2001; Turnhout 2003; Van den Boogaard 2002). Through this work, focus shifted away from the 'two communities' metaphor to the 'boundary' metaphor. The relevance of the literature discussed here is that the relation between science and policy as described in the case studies could be interpreted as veering away from the 'two communities' towards boundary work. In the subsequent case studies, science and policy initially operated as two distinct communities so to speak. In the first case study, an initial proposal for soil quality standards was developed in a policy published in a Discussion Memorandum, which was sent to the Technical Committee on Soil Protection for review. This review was partly adopted and the reference values were published in 1988 in a policy plan. Gradually, scientists and policymakers developed closer ties, and developed a sharedness that comes with boundary work. The sharedness that Jasanoff refers to can be seen in the first episode, during which science and policy are developing closer ties in an attempt to operationalise the guiding principle formulated in soil policy and explored by scientists in research programmes. In the second episode, the boundary between science and policy begins to disappear, showing a boundary between different types of science; regulatory science and research science. In the third episode the relation between science and policy becomes further blurred. On the one hand this has helped to develop research programmes in which policymakers and scientists are participating. On the other hand the blurring of the boundaries has evoked a debate about the responsibility of specific tasks in regulatory practice. For a detailed description and analyses of the cases, the reader is referred to the respective case study chapters (Chapters 5, 6, 7).

3.1.2 Knowledge for policy; from instrumental to tacit and from academic to socially robust

When the two communities metaphor was the dominant model in science studies in the 1980s, literature on the utilisation of knowledge was looking for a classification of knowledge. In a review article Rich (1997) identified (in retrospect) three classes: instrumental, conceptual, and strategic. Instrumental utilisation means a straightforward application of facts and findings. Instrumental utilisation could be 'measured' by tracking primary sources in policy documents, either by looking at the list of literature or by asking policymakers what scientific sources they had used. The operationalisation of the second (conceptual) and third type (strategic) was far more difficult. According to Rich, this difficulty had its roots in the rationalist bias of the literature on the utilisation of knowledge and the focus on output, instead of on process. Utilisation was on the good side and non-utilisation was on the wrong side. It seems that one of the earliest attempts to take a critical look at this utilitarian perspective on the role of knowledge in policy was a schedule by Larsen and Werner (1981). When they distinguished two categories they granted non-utilisation of knowledge a similar status to utilisation of knowledge. Both perspectives are different faces of the same medal: the role of knowledge in policy processes. The question could now be asked, what caused the difference between utilisation and non-utilisation?

Table 3.1 Creating meaning to non-utilisation (Larsen and Werner 1981).

Utilisation	Non-utilisation
• complete implementation of information as presented • adaptation of information • partial utilisation of information • steps that have been taken towards implementation, although full implementation has not occurred	• information has been considered by a potential user but then rejected • nothing is done with information • implementation of information has not occurred but is under consideration

Such a perspective can be recognised in the papers by Weiss, in which she explored the enlightenment function (or conceptual utilisation) of knowledge. Knowledge as enlightenment shapes our view on the environment in which we operate and plays a role in identifying problems and getting them on the political, scientific or societal agenda. Weiss developed the concept of enlightenment in a sequence of papers in the 1970s and 1980s (Weiss 1977, 1979, 1988) and it has been broadly used since then (MacRae 1991; Rose 1977). Weiss (1991) linked the types of utilisation, identified earlier, to types of knowledge or research. She classified research into: data, ideas, and arguments. The concept of 'research as data' included the notion of instrumental utilisation. It can be of importance in technically complex, confusing, and rapidly changing societal problems. In such cases, simple and straightforward information that clarifies the issue can make a world of difference and be of crucial importance to the decision-making process. The similarities between this concept and the instrumental utilisation concept are obvious. 'Research as ideas' has a more diffuse content and a more diffuse access to the policy arena. It typically influences and shapes the perception of the receivers or users of this type of knowledge. As such, this type of knowledge is less traceable than 'research as data' and it can be almost invisible in final outcomes or policy plans. As a third class, Weiss introduced 'research as arguments'. Weiss sketched a situation where a policymaker receives a note from a researcher or policy analyst in which research results have already been interpreted for the specific decision at hand. The interpretation has added an advocacy position to the research findings. It saves time for the policymaker and as such can increase the impact of knowledge in policy. In her paper Weiss suggested that researchers should consider adopting an advocacy position if they want their work to have a larger impact on policy. In doing so, she put the issue of the boundary between research and policy on the agenda; to what extent can scientists utter a political standpoint?

Zaltman en Deshpande drew a different typology: they distinguished between knowledge that confirms a decision-maker's belief and knowledge that challenges a decision-maker's belief (Zaltman and Deshpande 1980). This typology is a fine example of how the external criteria (see previous section) were used to qualify scientific knowledge. Not only scientific criteria can be used to qualify knowledge, but the match with policymakers' convictions can also serve as a criteria. Nowotny worked along the same line with her work on 'utilisation context' dating back to 1982. Her work was cited in an article on research utilisation strategies:

> …scientists stand in a complicated exchange relation to the context that receives their results. This context is not only a network of social relations, but also a conflict arena. In this arena, organizations, states, learned institutions, administrative agencies, private companies and fellow scientists all make significant appearances. The arena is made and structured by social forces and organized interests. This utilisation context determines how knowledge and concepts are to be understood and used …
> (Nilsson and Sunesson 1993 p. 25)

In a similar vein, Oh (1997) concluded in a review that the policy area in which the information is entered determines the use and he adds that this issue has received little attention in studies on the use of knowledge. Boogerd and co-authors (1997) showed that knowledge developed to formulate policy at national level was inadequate to solve local problems. In other words, whether or not knowledge is used depends on the context (in this case, the government level), and not exclusively on the content. In search of an adequate explanation for this phenomenon, Boogerd and co-authors argued that during implementation nationally defined policies are reformulated to fit regional and local problems. This redefinition may result in a problem definition rendering some knowledge useless while other knowledge is missing and hindering an adequate way of dealing with the local problem. Knowledge became contextualised in the sense that criteria to judge the relevance of scientific knowledge for policy, in other words, scientific criteria, were not sufficient and had to be complemented with criteria for the usability of scientific knowledge.

This section deals with the determinants of the appropriateness of scientific knowledge as usable knowledge. If it were no longer the internal CUDOS norms identified by Merton that could be used to distinguish scientific knowledge from tacit or lay knowledge, what were the grounds to assign more value to scientific (i.e.) academic knowledge compared to for instance tacit knowledge (Polanyi 1962), lay knowledge and local knowledge? The seminal work by Wynne on the Cumbrian sheep farmers (Wynne 1992) provided a clear case in favour of a more integrated approach. There are no reasons to grant scientific knowledge a more important or exclusive status over tacit and lay knowledge; scientists proved to be wrong, and lay people proved to be right, when it came to solving the problem of increased çesium levels and the threat to sheep farmers. It is this recognition that provides the groundwork for the development of interactive and participatory models in policy making, but also in setting research agendas (for reviews of such models see (Van de Kerkhof 2004), as a discussion of this literature is beyond the scope of my review). Jasanoff and others have suggested characterising the scientific knowledge selected for regulatory policy as regulatory science:

> Regulatory science, however defined, its purpose clearly is to produce techniques, processes and artifacts that further the task of policy development.
> (Jasanoff 1990, p. 76)

Jasanoff's distinction between regulatory science and research science is valuable for a differentiation between different types of scientific knowledge. In Chapter 6 boundary work takes place between these two types of science. Now that different forms of knowledge proved valid and useful in contributing to the solution of complex problems, the question has arisen as to what exactly differentiates scientific knowledge from other forms of knowledge. With that, the exclusiveness of academia as producer of knowledge was called into question. Now that academia was no longer considered as the exclusive producers of knowledge relevant to policy-making, the organisation of 'science-for-policy' was open to changes. Focus shifted from the production of knowledge towards context: what type of problems can we distinguish, what types of social structures are developing around these problems, and what, if any, is the relation between those types and the knowledge used in solving or managing those problems. Differentiations between structured, badly structured, unstructured and ill structured problems were used to distinguish between roles of (scientific) knowledge in solving these problems (Hisschemöller et al. 1997; Hisschemöller and Hoppe 1996). Such differentiations lined up well with new ideas about how to organise knowledge for policy. Notably, Funtowicz and Ravetz (Funtowicz and Ravetz 1990, 1992) put up efforts by differentiating between normal and post-normal science. In a similar vein Gibbons' and Nowotny's work on Mode I and II (Nowotny et al. 2001, 2003) sketched a new vista for science and knowledge production and use. This work is discussed in Section 3.1.3

The literature discussed in this section is relevant to this thesis in that scientific knowledge is considered with regard to its possible contribution to solving policy issues or to affecting the course of policy. It is compared to other types of knowledge in that respect. In the second case study, the demarcation of research science and regulatory science is one of the central issues.

3.1.3 The locus of knowledge production

Where academia used to be the locus for the production of scientific knowledge, its exclusiveness as the provider of knowledge for policy was increasingly questioned. Two lines of work in science and policy studies have addressed the infrastructure of knowledge production explicitly. Both will be discussed here. The first line of work finds its roots in the work by Funtowicz and Ravetz on different types of risk assessment. In their chapter (Funtowicz and Ravetz 1992) in the book by Krimsky and Golding on social theories of risk (Krimsky and Golding 1992) they write:

> We came to see that a full analysis of scientific problem solving in the modern world requires awareness of both the factual and the value dimensions of problems, and of the complexities in both.
> (Funtowicz and Ravetz 1992 p. 253)

Funtowicz and Ravetz claim that the traditional sciences (normal sciences) focus on regularity, simplicity and certainty (Funtowicz and Ravetz 2003), while the contemporary problems that society faces are characterised by uncertainties that are beyond the possibilities of normal science, requiring a new class of science, labelled: post-normal science[4]. These modern problems are characterised by uncertain facts, values in dispute, high stakes and urgent decisions (Funtowicz and Ravetz 1992 p. 254). A bit further in their text the authors state:

4 Funtowicz and Ravetz refer to 'normal science' in the work of Kuhn. The origin of this terminology will not be further explained because this would tempt me into a review on the sociology and philosophy of science, which would obscure the line of the review at hand and be beyond the scope of my thesis.

…in the face of such uncertainties, they (scientists) too are amateurs. Hence there must be an extended peer community and they will use extended facts…
(Funtowicz and Ravetz 1992 p. 254)

Typical of post-normal science is that it allows knowledgeable parties to participate in constructing knowledge needed to solve the complex problems. That is how this work is connected to boundary work; post-normal science changes the boundary between insiders and outsiders with respect to the production of knowledge necessary to solve problems and argues that the context determines the quality and not the production process per se.

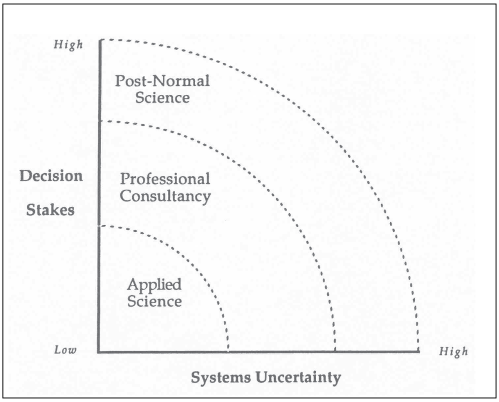


Figure 3.2 With increasing systems' uncertainty and increasing decision stakes, a different 'problem-solving strategy' is required, with different types of science compared to the normal, Kuhnian science. Funtowicz and Ravetz distinguish between applied science, professional consultancy and post-normal science at the outer perimeter. At the crossing of the axes basic, fundamental, science is located (Funtowicz and Ravetz 1992 p. 254).

One of the implications of post-normal science is that issues of legitimacy and quality control have to be reconsidered. Elsewhere more extensive reasoning was provided about the relation between legitimacy and institutional context (Souren 2003). Where academia as the locus of knowledge production had developed its own standards to assess the quality of scientific research, for instance, through peer review, these quality control procedures have to be reconfigured in post-normal science settings. Whose knowledge is valid, trustworthy and credible? This has produced further uncertainty but has most of all put pressure on scientists and other experts to expose their professional integrity and practices. In an analysis of issues related to uncertainty for scientists such new norms for scientific practices has been labelled as 'professional reflexivity' (Van Asselt and Petersen 2003). Funtowicz and Ravetz address the organisation of the knowledge infrastructure from a theoretical perspective.

The second line of work that addresses institutional reforms of science was not so much theoretically inspired, but rather empirically. Gibbons and co-authors wrote down their perspective in 1994 (Gibbons et al. 1994). They called the new arrangement, Mode II and contrasted it with Mode I. Mode II was characterised as operating within a context of application, with a transdisciplinary, rather than a monodisciplinary or interdisciplinary nature, and carried out in heterogeneous, non-hierarchical consortia that are not institutionalised like, for instance, in university structures. These differences, according to Gibbons et al, produced a knowledge system with a larger social accountability and reflexivity.

> The research towards the resolution of these types of problems has to incorporate options for the implementation of the solutions and these are bound to touch the values and preferences of different individuals and groups that have been seen traditionally as outside of the scientific and technological system. They can now become active agents in the definition and solution of problems as well as in the evaluation of performance.
> (Gibbons et al. 1994)

The criteria to judge the quality of the science produced by Mode II are evaluated by a larger group than the peer group of Mode I. The quality of Mode II science has to be judged in line with its context of application. The work by Gibbons and co-authors evoked discussions, but it was generally recognised that some sort of transition in the mode of knowledge production was indeed taking place. With this work, and the criticism it evoked, further attention was drawn to the social context within which knowledge is produced and judged. Stressing the contextualisation of science required a more thorough account of societal changes taking place, was a common criticism. A slightly renewed group of authors, challenged to contextualise the claim of an emerging new mode of knowledge production, composed a second book: 'Re-thinking science; knowledge and the public in an age of uncertainty' (Nowotny et al. 2001). Without going into the details of this second book, its main message is that science and society are indeed intertwined. This does not make science prone to attacks on its special status, but instead increases the robustness of knowledge, by its connection to society. This second book also poses new issues to be analysed as it still leaves open the question what contextualisation actually is, and what the implications are for the organisation of knowledge production.

In their work, the authors start from a different perspective compared to Funtowicz and Ravetz. Where Funtowicz and Ravetz address inadequacies of normal science to develop strategies to solve modern problems, Gibbons and co-authors attempt to explore changes in the mode of knowledge production (Gibbons et al. 1994 p.1). They start from observation and construct a framework for interpreting their observation, while Funtowicz and Ravetz are after a 'new design' of scientific practice. From the perspective of the organisation of the knowledge infrastructure it is hard to understand that these two groups of authors do not refer to each other in their basic publications. Apparently, the two groups of authors are in different disciplinary communities.

The relation between these two approaches and boundary work will be evident.

Boundary work is affected by, and affects, the institutional and social organisation of science in its relation to society and policy. The new mode of knowledge production, Mode II, appears as temporary and heterogeneous consortia, suggesting openness that is, however, not guaranteed. With the new locations of knowledge production emerging, the ownership and diffusion or dissemination of knowledge beyond the boundaries of the consortia have to be renegotiated, thereby introducing the issue of exclusiveness of produced knowledge. Through the backdoor, a new demarcation issue appears; those inside and outside the consortium have unequal access to knowledge produced within the consortium. The locus of knowledge production is a theme in the case studies. In the first episode, the production of scientific knowledge takes place in academia. In the second case-study, the two models that are the subject of debate are produced in the same university, but with a very different orientation towards the role of scientific knowledge in policy issues. In the third episode, the new research programmes NOBIS and SKB are examples of shifts in the research infrastructure as meant by Gibbons and co-authors. The criticism on Gibbons' and Nowotny's work has exposed the difficulty of conceptualising the context within which scientific knowledge is applied to solve or manage complex societal problems. Gieryn's plea for a better understanding of the organisational and institutional context remains in full force.

In the following sections the interpretative framework developed during the research is explained. What was searched for in the development of the interpretative framework was to develop a perspective complementary to the boundary work perspective. This would have to increase understanding of the organisational and institutional context within which labelling of usable knowledge takes place. In search of such perspective I scanned the literature on organisational and institutional theory for an approach that would allow me to describe the context of soil policy. The concept of institutional context as proposed by Scott did just that. It allowed trying and seeing what institutional perspectives can do to increase understanding of labelling processes in regulatory practices. The arguments applied in labelling connect regulatory practice to its institutional context and grant legitimacy to the labelling process.

Applying this concept from institutional theory does not imply that I have developed a full-fledged perspective on institutions. The concept of institutional contexts is more instrumental to my research. Clearly, the stated aim of the thesis is not to develop a fully fledged analysis of the institutional context, including the identification of different institutions or their roles in developing standards for soil quality. Rather the aim is to increase understanding of the labelling of usable knowledge for soil quality standards. The demarcation of the context, as explained in Chapter 2 was determined by the selection of the cases. That is to say that the perspective developed by Scott is instrumental to achieve that aim. There is a tension between the perspective on labelling usable knowledge given in the literature review compared to the more institutionally inspired framework developed in this interpretative framework. I am aware that institutional perspectives have a normative and prescriptive inclination. As we will see, Scott's definition is clear about this: institutes govern behaviour by focusing on what is socially acceptable. Scott's definition is uninformative about the possibilities of actual behaviour shaping and structuring institutional contexts in return. This tension between these two approaches is not solved in this thesis. Like so many researchers, I also ran into the limitations of the perspectives that float around, and set out to explore the possibilities of applying these perspectives that are, at first sight, in sharp contrast, but that are promising in the sense of increasing insight into the empirical material under scrutiny.

3.2 Putting together the interpretative framework

In the Chapters 1 and 2, the empirical focus and methodological perspective were outlined. In the first part of this chapter three themes concerning boundary work between science and policy were discussed in the literature review. Below, the interpretive framework is provided.

3.2.1 Regulatory practice and the labelling of usable knowledge

As explained before, the labelling of usable knowledge is an example of boundary work. 'Usable knowledge', together with some similar concepts, was discussed in the second part of the literature review. According to Lindblom and Cohen, usable knowledge refers to knowledge that is being used, and that contributes to solving a problem (Lindblom and Cohen 1979). According to these authors, there is not any characteristic inherent in the knowledge that determines its usability; rather, it is the institutional context that determines its usability. Conditions outside the knowledge itself determine its usability, so to speak. This tallies with the central assumption underlying the concept of boundary work: remember what Gieryn said about this in one of the works discussed before: factors outside the scientific domain determine the authority of science, and not criteria internal to the domain.

Alternative concepts, especially 'socially robust knowledge' (Nowotny 2003; Nowotny et al. 2001) suggest that social robustness is implicit in its production and second, robustness is a characteristic that can be assigned a priori. That may be the case, especially in knowledge production that starts from scratch on a complex and uncertain problem with high decision stakes. I doubt the usefulness of that concept to my research. In addition, socially robust knowledge does not get labeled afterwards, but is produced as such. The concept thus refers to a specific mode of production and not to a labelling practice. In the three successive cases, I searched for the scientific knowledge that was used to calculate and model the height of the standards for soil quality. As the interest in the research described here is in this labelling process, a concept like socially robust science would be inadequate on methodological grounds; I do not analyse different modes of production. Nor do I evaluate their appropriateness for the production of usable knowledge. If I had taken this methodological perspective, the work by Nowotny would have been adequate.

Labelling usable knowledge is typically what policy and science do in regulatory practices; they select usable knowledge to calculate the height of the concentration levels that afterwards become standards for soil quality, published in policy documents and implemented in soil policy. Usable knowledge is scientific knowledge accredited by scientists and policymakers involved in developing standards to calculate the concentration levels of substances. The labelling of this knowledge is a social process in which arguments are applied. What are the arguments scientists and policymakers use in labelling? The literature on this issue provides a number of arguments for qualifying knowledge. These include arguments concerning scientific quality or methodology (i.e., the number of replicates, applied techniques, protocols, methodological biases, qualification of personnel (Schotland and Bero 2002; Yearley 2002). A number of studies point out that usable knowledge establishes a match between the scientific and the policy discourse. Remember the distinction made by Larsen and Werner, discussed in the first literature review in Section 3.1.2, between knowledge that does or does not match with policy. Scientifically sound knowledge that does not match policy principles or goals will not be labeled as usable knowledge.

3.2.2 Regulatory practice

In Chapter 1 it was explained that standard setting can be interpreted to take place in an overlapping area between science and policy. Standard setting has to relate to science on the left side of Figure 3.3, and on the right, standard setting has to relate to policy. For an understanding of the empirical material and for an understanding of the guiding question such visualisation was adequate.

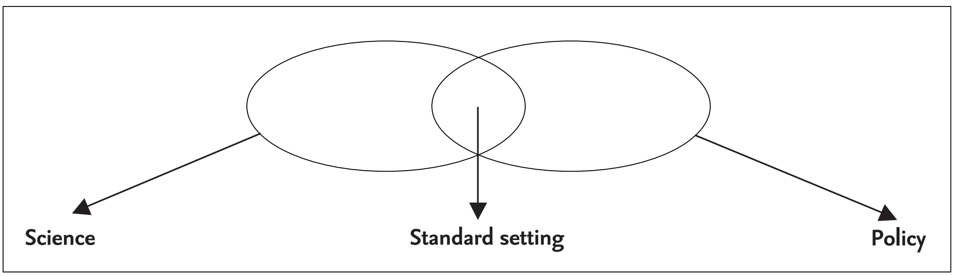


Figure 3.3 Standard setting at the overlap of science and policy.

It would be all too easy and perhaps tempting to simply label the middle part as 'regulatory practice'. Regulatory practices analysed from such a perspective would produce accounts about a new emerging domain that has to relate in some way or another to science and policy and become institutionalised. A regulatory domain would emerge, and all could start anew. Such perspective would focus on how regulatory practices are demarcated relative to the domains of science and policy. This is the approach used in, for instance, Jasanoff's work and Gieryn's work, in which the boundary between science and policy is stretched into a boundary zone. However, this creates mainly new boundaries that have to be demarcated and from a methodological perspective such work does not lead to new approaches and insights. In short, this is not the perspective pursued here. Chapter 2 explained the methodological approach and presented the visualisation repeated here.

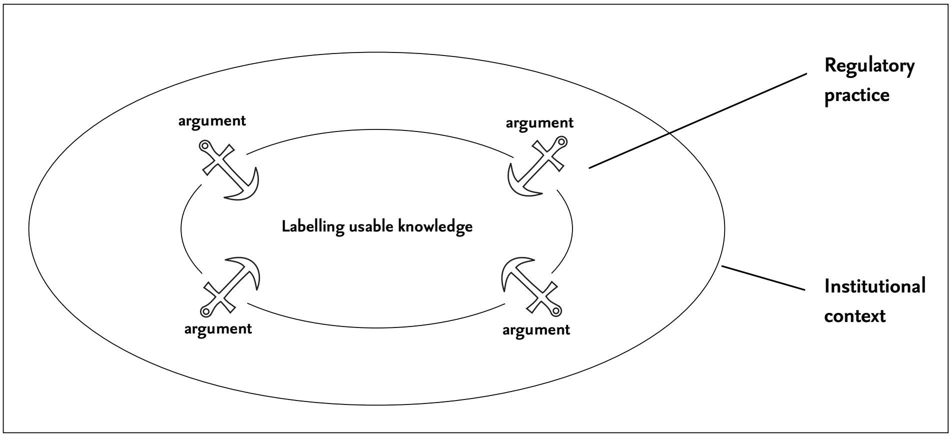


Figure 3.4 Visualisation of the relation between context (institutional context, Chapter 4) and case studies (regulatory practice, Chapters 5, 6, and 7). The inner and smallest ellipse represents regulatory practice. In regulatory practice labelling of usable knowledge takes place. The arguments used for this labelling process connect and anchor regulatory practice to the institutional context; the outer ellipse.

This figure visualises regulatory practices embedded in an institutional context (of which science and policy are constituents). In the case of labelling usable knowledge as a typical process within regulatory practices, the arguments applied in labelling are the 'devices' that anchor regulatory practices in an institutional context. The arguments used in labelling connect regulatory practice to the institutional context. Typical about the selection or labelling of usable knowledge is that both science and policy are involved in this process. This is the type of boundary work where the boundaries are transgressed on purpose, where science and policy merge, and any distinction of a boundary between science and policy is both ambiguous and irrelevant. Therefore I searched for a concept in the interpretative framework that would not make such distinction but rather would stress the sharedness of science and policy. Compared to boundary work, where science and policy are connected but distinguished by a boundary (flexible, but still present), practices go beyond the co-production view. The concept of practice solves the problem of distinguishing the activity to the structure that has plagued the boundary work concept (Pickering 1995; Schatzki et al. 2001). In the concept of practice, it is no longer necessary to distinguish between scientific and policymaking activities as it is also no longer necessary to distinguish a policymaker from a scientist. Even while applying the practice concept, there may still be empirical grounds to distinguish between scientific and policymaking activities, and most likely, new demarcations within practices would be distinguished. Exploring the labelling of usable knowledge in (developing) practices makes it possible to evaluate the arguments for labelling without having to class them either typically under science or typically under policy.

3.2.3 Legitimising the labelling of usable knowledge

The above section argues that regulatory practices are embedded in institutional contexts. The relation between the two is not as noncommittal as it might seem. In fact, processes like the labelling of usable knowledge are legitimated through the relation between regulatory practice and institutional context. In case the arguments for labelling are not grounded in the institutional context within which the standards are developed and implemented, labelling, and, consequently, regulatory practice, might lose its credibility. Consequently, understanding regulatory practice and how it evolves over time requires an analysis of the institutional context and of the relation between the arguments applied in labelling and in the institutional context. A useful and widely accepted definition of legitimacy is the formulation by Suchman in 1995.

> Legitimacy is a generalised perception or assumption that the actions of an entity are desirable, proper or appropriate within some socially constructed system of norms, beliefs and definitions. (Suchman 1995, p. 574)

Applied to the process of labelling, the socially constructed system of norms, beliefs and definitions provides legitimacy to the labelling of usable knowledge. Legitimacy issues have been and still are subjects of research in institutional theory. The creation of institutions and the way institutions at the same time create meaning, change and stabilise our behaviour is the subject of institutional research. In search of an adequate concept to complement the interpretative framework of this thesis, institutional theory was explored strategically rather than exhaustively.

3.2.4 Institutional context

In his review of institutional theory, Scott (1995, 2001) distinguished economic, sociological and political traditions. Without ignoring their differences, Scott identified three dimensions[5] of institutions that can be recognised in these traditions and he proposes the following omnibus definition of institutions:

> Institutions consist of cognitive, normative and regulative structures and activities that provide stability and meaning to social behaviour.
> (Scott 1995)

In the second edition of his review, Scott coupled the definition of legitimacy by Suchman to his analysis of institutions when he wrote:

> The socially constructed systems to which Suchman refers are, of course, institutional frameworks. And… each of the dimensions provides a basis for legitimacy, albeit a different one.
> (Scott 2001)

Scott argues here that the three dimensions of institutions are sources to legitimise social behaviour (in this case: the labelling of usable knowledge). Applied to this thesis, this translates into the claim that the dimensions of the institutional context can provide legitimacy to the labelling of usable knowledge. Hence, for any regulatory practice to maintain stability and credibility the arguments for labelling of usable knowledge should be based on any or all of the three dimensions. In the cases studies, the arguments applied in labelling are identified and their relation to the dimensions of the institutional context is analysed.

Scott's distinction between the three dimensions has been used by several authors in analyses similar to the analysis in this thesis. Troast and co-authors, for instance, used the concept of institutional context as developed by Scott, to understand the negotations over a specific Habitat Conservation Plan within the context of nature conservation policy and forestry policy in the US (Troast et al. 2002). Arguments used in the formulation of the Habitat Conservation Plan were analysed and traced back to the three dimensions of the institutional context. In doing so, the authors identified the sources of these arguments. Interestingly, Troast concluded that these arguments were decisive in the selection of the 'best science'. The selection of the 'best science' was interpreted as an attempt to depoliticise the debate and

5 Scott labels them as pillars. Given the criticism that Hirsch, for instance, formulates in his lengthy review (Hirsch 1997) , but also see Scott's response (Scott 1998), I have chosen to change 'pillars' into 'dimensions'. Together, the dimensions shape the institutional context.

to solve disputes between involved parties. The scientific knowledge ultimately labelled 'best science' became the legitimating or framing device, and it served to both constrain and empower the behaviour of the actors in the negotiation' (Troast et al. 2002 p. 248).

A second research project related to the research described in this thesis that has used the concept as developed by Scott, is a study by Delmas and Terlaak (2002). These authors analysed environmental Voluntary Agreements as 'practices' embedded in institutional contexts. In a comparative study on the US and the Netherlands, they showed that the relation between the three dimensions could be indicative of the outcome and success of such voluntary agreements. These two studies (by Troast et al., 2002 and by Delmas and Terlaak 2002) and the approach applied in this thesis have in common the analysis of a practice (negotiation, voluntary agreements, regulatory practice) as embedded in an institutional context and also share the idea that the legitimation of such practice hinges on its connection to the wider institutional environment. Table 3.2 gives the features of each dimension.

Table 3.2 Characteristic features of the dimensions of institutional context. (Adapted from Scott 2001 p. 52).

	Dimension		
	Regulative	**Normative**	**Cognitive**
Basis of compliance	Expedience	Social obligation	Shared understanding
Indicators	Rules, laws, sanctions	Certification, accreditation	Common beliefs, shared logics of action
Basis of legitimacy	Legally sanctioned	Morally governed	Comprehensible, recognisable, culturally supported

Scott allows a large degree of freedom for researchers to interpret the three dimensions. Consequently, several authors have pointed out the relatively loose definition of the dimensions and have criticised his approach for this reason (Delmas 2002; Hirsch 1997; Hoffman and Ventresca 1999). Although these critical comments seem valid, I still find his approach adequate and have found proof for this in the studies mentioned above. In its simplicity, the concept as elaborated by Scott makes explicit and operational that institutional contexts are multidimensional, but also that processes such as the labelling of usable knowledge in regulatory practices must be interpreted in a wider context. One of the issues encountered while applying Scott's concept in this research is that the process central to this thesis (labelling usable knowledge) mainly concerns the cognitive dimension. The meaning of soil, clean, polluted, risk, adverse effects, etc. (all cognitive concepts) is largely determined by scientific knowledge and, consequently, the labelling process largely determines the meaning of these concepts. The mere fact that this thesis focuses on a process that is determinant of the cognitive aspects of soil quality standards might implicate that the arguments for labelling are connected to the cognitive dimension of the institutional context. If it were the selection processes for members of advisory committees that were central to the research in this thesis, it could, in a similar vein, be hypothesised that the arguments for this selection would be related to the normative dimension. In my research I have not further elaborated on this issue. If I had chosen to study the functioning of regulatory practices more widely, it would have been adequate and interesting to compare processes that were related to the different dimensions. The cognitive and normative dimensions stand out in the description of the context in Chapter 4. Hence, these two dimensions will be explained in more detail and the explanation of the regulative dimension will be limited.

Regulative dimension

The regulative dimension is characterised by Scott with the indicators: rules, laws and sanctions (Scott 2001 p. 52). The regulative dimension in institutional context has expedience as its basis of compliance and coercive mechanisms. The logic of the regulative dimension is an instrumental one (March 1981) and the basis of legitimacy is legal sanctioning. Applied to the labelling of usable knowledge, arguments based on references to legal frameworks would qualify as 'regulative criteria'. Standards for environmental quality have an important legal function as it comes down to the issue of legal responsibility for cleanup, or for claims concerning human health. The legal aspects of standards become crucial in cases of the use of standards as targets for cleanup, or with standards or indicators related to human health (see Delmas 2002). It is expected that the regulative criteria will not play a major role in the labelling of usable knowledge for soil quality standards.

Normative dimension

The normative dimension according to Scott:

> …defines goals or objectives (e.g., winning the game, making a profit) but also designates appropriate ways to pursue them (e.g., rules specifying how the game is to be played, conceptions of fair business practice).
> Some values and norms apply to all members, whereas others apply only to elected types of actors or positions. The latter gives rise to roles: conceptions of appropriate goals and activities for particular individuals or specified social positions.
> (Scott 2001 p.55)

As this formulation makes clear, the normative dimension of institutional contexts is about social order, what roles there are and how these are distributed. One the one hand, the normative dimension delimits the possibilities for social behaviour, but at the same time it enables social behaviour as it explains roles and the responsibilities and tasks as they have been agreed upon. Scott focuses his description of the normative dimension on the social obligation that actors have, based on moral principles. Social obligation is the basis of compliance, with the logic of appropriateness (March 1981) and certification and accreditation as indicators. The normative dimension provides stability, a social order and facilitates communication and actions (Bansal and Penner 2002).

The institutional context within which environmental quality standards are developed was initially dominated by a limited number of actors, as we will see in the first episode, described in Chapter 4. In subsequent episodes, the number of actors increased, as well as their heterogeneity. In the sequence of the case studies, we will see that the normative dimension becomes increasingly determinant of the institutional context.

Cognitive dimension

The cognitive dimension[6] refers to:

> …shared conceptions that constitute the nature of social reality and the frames through which meaning is made.
> (Scott 2001 p. 57)

Scott draws from researchers from the neo-institutionalist tradition stressing the importance of frames and beliefs to explain the basis of compliance. It is this cognitive aspect that emphasises the importance of taken-for-granted-beliefs to which organisations conform (Zucker 1983). The cognitive dimension is located by Zucker (1991) at the level of the individual, whereas the normative and regulative dimensions according to Zucker operate at the level of the field or organisation. This assumption explains why institutional theory is more elaborate with regard to processes governing the normative and regulative dimension than the cognitive dimension. Whereas institutional theory stresses the role of institutions in diffusing perceptions, it is not exactly clear to what extent, if any, disagreement or diverging perceptions constrain or are constrained by the cognitive dimension. Put differently, the sharedness of the meaning is not crucial, but rather the fact that issues are framed cognitively is what determines the degree of cognitive institutionalisation

6 In his second edition, dated 2001, Scott uses the term cultural-cognitive. In his first edition, he uses the term: cognitive. I am using the terminology from his first edition.

(Bansal and Penner 2002; Scott 1995) This is not to say that the cognitive dimension is considered less important; institutional theory recognises that the meaning or interpretation of its members is central to understanding institutionalisation as a process (DiMaggio 1991). Zucker (1983 p. 2) puts it strongly when she argues that shared cognitions define what has meaning and what actions are possible. Sharedness as a precondition for institutional coherence has dominated institutional theory. Bansal and Penner (2002), however, challenge this assumption. Their work on newspaper firms shows that different interpretations can exist without challenging the coherence of the institutional context. They also argue that the cognitive dimension is most difficult to control. A high level of discord on the cognitive dimension may be instrumental in later initiating regulative and normative institutional changes. According to this work, agreement on cognitive aspects within institutional contexts seems to be indicative of its stability.

Regulatory practices as discussed in the previous sections centre on issues of risk, environmental quality and safety. Regulatory practices thus tend to have a cognitive inclination. In this respect, they neatly fit into the analysis Scott gives about the conditions giving rise to new institutional arrangements, based on the work of Suchman (1995) and Weick (1995). The development, recognition, and naming of a recurrent problem to which existing institutions have not yet provided a satisfactory repertoire of response is a strong basis for new emerging institutional structures. The importance of the development of shared meanings is also stressed by Choo (Choo 1996, 1998) in his work on the 'knowing organisation' and on 'making sense in organisations'. In her MSc thesis, Buijk (2005) argued that the development of a shared understanding of the concept of sustainability, through 'making sense', would strengthen the position of a new regional organisation concerning sustainable water management in the Dutch river area amongst other organisations in the region.

It is the cognitive dimension of institutional contexts that is close to the argumentative and discursive tradition in policy studies and science studies. Examples of this are to be found in (Fischer 2003; Fischer and Forester 1993; Hajer 1995). Several of the cases analysed in this thesis will show that cognitive arguments are used in the labelling process. An issue for further research would be whether this is so because of the earlier mentioned cognitive inclination of regulatory practices. A second question to be addressed is that other selective processes in regulatory practices should be scrutinised for the arguments. For instance, membership of committees concerning regulatory activities would provide interesting case material. If the cognitive inclination of regulatory practices is most important, the arguments used in selecting such committee members might as well be dominated by cognitive arguments, or, as committees are normative structures, would they be normative arguments then? As labelling usable knowledge is largely concerned with the cognitive concepts in regulatory practices, it is likely that cognitive arguments dominate. It is presumed that the shared understanding of concepts like soil, risk, adverse effects, pollution, soil quality and others determine the existence of a regulatory practice and to a certain extent provide the main criteria applied in the labelling of usable knowledge for standards. In the final section of this chapter the research questions are brought together.

3.3 Research questions

In this chapter the framework to interpret the empirical material is developed. The guiding question formulated in the introductory chapter was:

> *How can we understand the labelling of usable knowledge for the development of soil quality standards in terms of boundary work between science and policy and in terms of the relation between regulatory practice and its institutional context?*

This guiding question is addressed by analysing the institutional context within which this labelling takes place. The labelling process is done in regulatory practices where boundary work abounds, legitimised by connecting the arguments for labelling to the dimensions of the institutional context. The concept of institutional context is used to enhance understanding in a direction proposed not only by Gieryn (1999). Also in the programme 'Rethinking the science-policy nexus', the boundary work metaphor is being stretched to include institutional aspects. Also, in her thesis Turnhout (2003) came to the conclusion that for a further understanding of boundary work and the role of science, the organisational context would have to be taken into account. In short, what this thesis tries to show is that the application of an institutional perspective as complementary to boundary work does enhance our understanding. To do so, the following five research questions have been formulated.

1. *How can the institutional context be characterised? (Chapter 4)*
2. *What knowledge is labelled as usable knowledge? (Chapters 5, 6 , 7)*
3. *What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context? (Chapters 5, 6 , 7)*
4. *How does regulatory practice develop during the research period? (Chapter 8)*
5. *How do the dimensions of the institutional context affect the labelling of usable knowledge in regulatory practice? (Chapter 8)*

In Chapter 4, a concise interpretation of the recent history of soil policy and science is given. The three dimensions of institutional context are used in that chapter to describe the developments and to distinguish and characterise three episodes.

Chapter 4 will thus provide the answer to the first research question. In the subsequent case chapters (Chapters 5, 6, 7) the second and third questions are addressed and the labelling of usable knowledge for the subsequent sets of standards for soil quality is analysed. In the concluding chapter (Chapter 8) the last two questions are addressed and the respective questions and answers are put back into perspective.

CHAPTER 4

Solidified regulatory practice

In the first part of this thesis (Chapters 1, 2 and 3) the interpretative framework, methodology, and research questions were developed. In this second part (Chapters 4, 5, 6 and 7), the empirical material is presented. The present chapter provides an interpretation of soil policy as the context within which usable knowledge was labelled for the successive soil quality standards. The chapter gives an overview of the developments between 1971 and 2000.

Writing a concise history of a policy field is prone to criticism from insiders. Inevitably, the overview in this chapter is not exhaustive. It has not been my aim to write an all-encompassing history of the field. My aim has been to provide a careful interpretation of recent history for the purpose of my study: to better understand the arguments that are used in labelling usable knowledge for soil quality standards and to understand how regulatory practice and institutional context are linked. The recent history provided here is composed for that purpose. In addition, a second and more critical issue could be brought up, concerning the method applied to analyse and describe the institutional context. As explained in the previous chapter, I have 'sorted out' the material collected during my research and have distinguished three episodes in the recent history of the field. I sorted out all material by using the three dimensions as distinguished by Scott. While doing so, a number of difficulties became explicit. These boil down to the relatedness of the dimensions. While sorting out the empirical material it became clear that several events, achievements and developments could be assigned to more than one dimension. It cannot be objectively established whether a particular event, achievement or development should have to be classified as cognitive, normative or regulative. For instance, cognitive concepts (cognitive dimension) are developed through interaction between actors (normative dimension). As it is, the cognitive and normative dimensions are closely related. The same holds for the regulative and normative dimension. Acts and rules (regulative dimension) are developed and maintained in the interaction between actors (normative dimension). Because of this interrelatedness, the cognitive, normative and regulative dimensions cannot be distinguished unambiguously. The rationale for the distinction made during this research was that events, achievements and developments that were mentioned or used in interviews and documents as important for the relations between different actors, were grouped as normative. Other events, achievements and developments were interpreted either as regulative or cognitive.

In the remaining part of the Chapter the three episodes are described and explained. While trying to stay close tp the empirical developments I follow the three dimensions in my explication. At the end of the explanation of each episode, that episode is summarised in a table, given an overview of the events, achievements and developments.

4.1 Getting started: 1971-1988

4.1.1 Developing a legal framework for soil policy

In April 1971, the Preliminary Soil *Pollution* Act was submitted (Min.V&S 1971). The Act urges to prevent soil pollution mainly because of its adverse effects on water quality and storage. When political fencing threatened to delay an integral development of the Act, it was proposed to extract Waste and Chemical Substances from the Preliminary Act and to develop separate Acts on these issues first. Repeatedly in speeches to Parliament, in the Queen's speech in 1974 and in the working plans of the Ministries, the Soil *Protection* Act was announced. However, progress was still slow. One of the causes of the delay was attributed to the specific characteristics of soil; soil pollution is often invisible, hidden underneath. In addition, soil was perceived as a resource, in the sense that it supplied services, such as providing the basis for infrastructural works. Soil was subservient to infrastructural works and was not perceived as an environmental compartment worth being protected for intrinsic values. A third cause of the delay, and a more political one at that, was the fact that there already were a number of Acts that included aspects of soil protection. The implementation of such Acts was the responsibility of several ministries, including Economic Affairs, Agriculture and Fisheries, Public Housing and Spatial Planning, and Infrastructure and Water. Not surprisingly, considerable political resistance existed against the development of an overarching legal framework for soil protection as such an Act would inevitably reduce the authority of some ministries. This was a political factor that delayed the publication of an overarching Soil Protection Act. As an example of this resistance, the Ministry of Agriculture and Fisheries as the strongest opponent claimed authority for the protection of agricultural soil by referring to the Act on Manure and Fertiliser, and the Pesticide Act of the Ministry (Min.L&V 1976). The dispute about competence between the Ministry of Public Health and the Environment, and the Ministry of Public Housing and Spatial Planning, centred on the authority over spatial planning issues. The line of reasoning of the Ministry of Public Health and the Environment – by then responsible for the Preliminary Act – in countering these oppositions was that the high pressure on land and the multiple interests involved required the formulation of an overarching soil policy, protecting the quality of soil. In an attempt to resolve the dispute over the development of an overarching or complementary Soil Protection Act, a ministerial committee (MICOB), chaired by the Prime Minister was installed in 1976 (MICOB 1976). After two meetings, chances of a solution to the dilemma were perceived to be minimal. In an attempt to force a breakthrough in favour of an overarching act, the then Minister of Public Health and the Environment, Vorrink, send a detailed letter to the Prime Minister (Min.V&M 1976c). Enclosed with the letter was an extensive document with the revealing title: *'Further underpinning of the need to develop an overarching soil protection policy* (Zeilmaker 1976). This document contained an extensive overview of soil characteristics and potential threats to soil quality and a formulation of what was meant to be the guiding principle of soil protection policy. The document was an utterance of the body of knowledge developed at the Ministry and responded to repeated calls for an overview of threats to soil quality. Also a list was provided with acts, committees, institutes and research groups concerned with science or policy on soil quality. The Prime Minister sensed that a solution within the MICOB was out of reach and took the issue back to the Cabinet. In October 1976, the Cabinet decided that the Soil Protection Act would have to be complementary instead of overarching as proposed by the Directorate General Environmental Policy (DGMH) and the Ministry of Public Health and the Environment. An inventory of activities that complemented existing Acts revealed that only the 'scattering of salt and sand on icy roads' was not yet regulated and would be the only issue to be regulated in the complementary cct. The Ministry of Public Health and the Environment did not give in. Awaiting a change in favour of the development of an overarching act, the department of Soil within the Ministry of Public Health and the Environment meanwhile further developed knowledge on soil and soil quality standards. Research projects were formulated, and a research programme (Soil Protection) was launched.

What opened the window to proceed with an overarching act was the disclosure of a polluted urban area (Lekkerkerk) in April 1980 and a number of severely polluted sites shortly after (Merwedepolder, Griftpark, Volgermeerpolder). Chapter 1 pointed out the importance of this discovery for the progress of soil policy and, consequently, for the development of soil quality standards. The development of soil policy gained momentum. However, the Ministry of Agriculture and Fisheries persisted in its resistance. In a comment on a revised version of the act, its opposition was still fierce. In a letter to the Ministry of Public Health and the Environment, the Ministry of Agriculture and Fisheries claimed to have all necessary knowledge on soil and soil quality, and objected to the establishment of a Technical Committee on Soil Protection (TCSP) in the act (Min.L&V 1980). This committee was meant to advise the Ministry on technical aspects of soil policy. This resistance was not effective, and within a few months after the discovery in Lekkerkerk, the Soil Protection Act was sent to the Lower House in December 1980 (Min.V&M 1980). As priority lay with the cleanup of the polluted sites, the necessary legal procedures for cleanup were taken from the Soil Protection Act, and adapted as the Interim Soil Pollution Act. This Interim Act was approved in stages between January and April 1983.

In the Interim Soil Pollution Act, a first set of standards (ABC values) for soil quality was published (Min.VROM 1982). The ABC values were developed by the Inspection of Health as an internal guideline in 1982 (Inspectie Milieuhygiëne 1982) to facilitate quick assessments of the quality of polluted sites with respect to the risk to human health. As it was the only standard available at the time, these ABC values were widely used as targets for the cleanup of sites.

> The ABC values had been developed, as it were, on 'a rainy Sunday afternoon' by one of the Inspectors. Nevertheless, we were in need of such a framework and we all carried a copy in our pocket.
> (Interview quote from a regional policymaker, responsible for treatment schemes at the time)

With the publication of the ABC values in the Interim Soil Pollution Act came a scheduled evaluation of the standards. It was not until 1987 that the Soil Protection Act was accorded as well. In this act, the principle of multifunctionality was formulated as the guiding policy principle for soil policy (see Section 4.1.3 for further explanation of the principle). Soil protection policy would have to result in soil of a quality enabling multifunctional use. Although formulated as the aim of preventive soil policy, the principle was soon used as the target level for cleanup. Initially the ABC values were applied, but later on, the reference values were used as indicators for 'good' soil quality. These targets for multifunctional soil quality (initially the A values, later the reference values) were difficult to achieve. It soon turned out to be difficult (technically) and expensive in many cases to reach the concentration levels. To accommodate these cases, a clause was formulated in the act (Article 38), stating that multifunctionality was the target of cleanup, **unless** location-specific circumstances were such that isolation, containment and monitoring measures (ICM measures)[7] would suffice. These location-specific circumstances could be financial, technical or environmental and were so broadly formulated that many polluted cases

7 Dutch: Isoleren, Beheersen, Controleren (IBC maatregelen)

qualified for ICM measures. Clearly, the specification of the guiding principle of multifunctionality in the Soil Protection Act had farreching implications. By 1987, the Interim Soil Pollution Act and the Soil Protection Act existed next to each other. It was not until 1994 that these two legal frameworks were integrated.

This section described the development of the legal framework for soil policy in the early years of soil policy. The legal framework was important for the further development of soil policy and standard setting. Firstly, the legal framework provided the ground for the development of standards. Already in the Priority Memorandum on the Environment (Urgentienota milieuhygiëne) (Min.V&M 1972) and the Memorandum Environmental Health Standards (Nota milieuhygiënische normen) (Min.V&M 1976b) the development of standards was announced. Secondly, the development of the legal framework made clear that several ministries were involved in soil quality. I restricted my research to the Ministry of Public Health and the Environment (that after a merger in 1982, became The Ministry of Public Housing, Spatial Planning and the Environment). Thirdly, the Technical Committee on Soil Protection (TCSP), was established in the Soil Protection Act. This committee would have to provide advice about soil policy. This illustrates the importance given in the policy field to scientific grounds for soil policy.

4.1.2 The conceptual development of national soil policy

In 1971, by the time the Preliminary Soil *Pollution* Act was submitted, the Ministry of Public Health and the Environment was established (see for a biographical impression of the start the memoires of the first director-general, prof. dr. Reij (De Koning 1994). Within the Ministry, the Directorate General Environmental Policy was responsible for environmental policy. In 1972, the Soil Sector was established within this Directorate General next to the Sectors Water and Air. This Sector was responsible for a variety of remaining issues that had in common that they did not fall under the Sectors Water and Air within the Ministry. A variety of subjects ranging from radiation and noise to toxic substances and soil protection fell under this sector, the garbage can of environmental issues, so to speak. For the other environmental compartments a legal framework, as well as quality standards had already been developed. The main task of the sector was to develop a legal framework for soil policy and to develop standards for soil quality.

Standards for environmental quality had been identified already as important instruments in environmental policy before (Min.V&M 1972, 1974). In 1976 the Memorandum Environmental Health Standards was published (Min.V&M 1976b), underlining this importance. This document was meant to give an overview of environmental quality standards and to look ahead. In the introduction, the Memorandum explains that the development of soil quality standards trails behind; soil quality standards are not addressed, awaiting the development of the legal framework and the results of the Soil Protection research programme (see Section 4.1.4). The Memorandum is nevertheless of particular interest here as it reveals the current ideas about environmental quality standards. Given the heterogeneity of ecosystems, it was believed that the natural occurrence of substances in ecosystems serves as no-effect levels. Concentration levels measured in such ecosystems therefore would indicate the no-effect level. As we will see in Chapter 5, and further, the measurement of concentrations in such areas does not only reveal natural occurrence, but includes diffuse pollution.

In various comments on this Memorandum Environmental Health Standards, it is argued that the use of standards as policy instruments was insufficiently elaborated on. The difference between qualitative and quantitative standards had not been explained. Also the Provisional Central Environmental Council (VCRMH) (later: CRMH Central Council on Environmental Protection) was critical about the insufficient consideration that was given to the fact that the development of standards was mainly a political process. That implied, according to the VCRMH that scientific research was required to analyse and understand the social and economic impacts and meaning of environmental quality standards. Such research was considered necessary to complement scientific research into effects of substances. The VCRMH furthermore noted that the results of the scientific research would not be available by the time that standards had to be set. The development of standards therefore would have to built on available research (VCRMH 1977, 1980). In addition to the VCRMH, the Health Council formulated comments on the Memorandum Environmental Health Standards (Gezondheidsraad 1978). The Health Council was established to give advice on human health aspects of policy. Its comments on the Memorandum focused on this aspect. As soil policy focused on the ecological function, the advice of the Health Council is of limited relevance to soil policy. However, the advice addresses standard setting in general and comments on the relatively loose definition of what environmental standards are in the Memorandum. The Health Council urges to be more precise on this in future policy plans. In the first episode, the role of the Health Council for development of soil policy is limited. In episode 2, the role of the Health Council is much more important. The main reason for this is that the mission of the Health Council was extended meanwhile, increasing the mandate of the Health Council on environmental issues.

In 1979, within the Soil Sector at the Ministry, the Department of Soil Protection existed next to the Department of Ecology and Environmental Toxicology and to the Department of Research and Development. Initially, soil protection was a minor issue. Soon after the discovery of landfills and waste dumps at the end of the 1970s and early 1980s (Lekkerkerk, Volgermeer, Griftpark) soil protection became predominant on the political agenda, and additional resources were made available. With this money, staff was hired with technical knowledge on soils. A significant amount of the research budget was allocated to a soil research programme. By 1980, the Department of Soil Protection consisted of an enthusiastic, dedicated, staff that could avail of technical knowledge on soils.

> There was a time when the Minister had to appear almost daily in parliament to discuss issues pertaining to soil policy… and to provide files on specific issues. The department worked very hard on these issues.
> (Interview quote from policy staff member at the time)

By 1981, through a reorganisation, the Directorate Soil, Water, and Substances was established. This Directorate existed until 1988. In 1982, a second reorganisation took place resulting in a partial merger between the reorganised Ministry of Public Health and the Environment and the Ministry of Public Housing and Spatial Planning. Environment now became part of the new Ministry: Ministry of Public Housing, Spatial Planning and the Environment (VROM). An important policy document prepared by this staff was the Preliminary Soil Policy Plan (V-IMP Bodem) (Min.VROM 1983). This policy plan was supposed to bridge the gap between the acceptance of the Interim Soil Pollution Act (1983) and the acceptance of the Soil Protection Act (awaited in 1985, but eventually put into effect in 1987). The Preliminary Soil Policy Plan contained the outline of what was called 'interim' soil protection policy. It reflected on soil policy and research until then, but most importantly it provided an outline of protective soil policy. It was referred to extensively in documents about research programmes (Section 4.1.4) and became the reference point for soil policy since then. The plan also announced that the Advisory Council for research on nature and the environment (RMNO) would get involved in the subject of soil policy. This advisory council was established in 1981, to assist the government in interpreting the relation between human activities and environmental change. Within the advisory council, a platform for soil research (PSG-Bodem) had already been established. Besides its description and reflection on soil policy and research until then, the Preliminary Soil Policy Plan formulated what was to become the backbone of soil policy. This backbone of soil policy was provided by the principle of multifunctionality. This principle describes the quality of soil, and in doing so, sets the objectives of soil protection and soil pollution. The concept is explained in Section 4.1.3 and will re-appear throughout the thesis as it has played a dominant role in the development of soil quality standards.

After the discovery of several polluted sites in the 1980s, policy on soil treatment, the curative track of soil policy, had become increasingly complex. In 1984, within the Directorate Soil, Water, and Substances, two separate departments were established: one on Soil Pollution and one on Soil Protection. In the latter department the Discussion Memorandum Soil Quality was written in 1986 (Min.VROM 1986). This Discussion Memorandum proposed a list of standards for soil quality (Provisional reference values). This particular document initiated the development of the reference values described in Chapter 5. Since 1986, further differentiation of the department took place. Soil Protection was split into two departments: Diffuse pollution and Local pollution. At the same time, Departments on Substances and on Standards emerged and proliferated within the Directorate General (SDU 1978-1988). In the first episode the number of staff concerned with soil policy increased and indicates the growing importance and position of soil policy. This growth was facilitated by the development of the guiding principle for soil policy. This principle is explained in more detail in the following section.

4.1.3 The guiding principle for soil policy; multifunctionality

The principle that has guided the development of soil policy and of standards for soil quality was the principle of multifunctionality. The history of the concept dates back to the Explanatory Memorandum of the Preliminary Soil Pollution Act published in 1971.

> It can be said that soil is polluted when its physical, chemical and biological characteristics have been changed either through human interventions or otherwise, in such a way that soil is less well equipped for functions it previously fulfilled.
> (Min.V&S 1971)

The protection of soil quality was formulated very ambitiously; soil quality had to be such that any use must be possible at any time and any place. Early 1976 'multifunctionality' appeared for the first time in the minutes of the ministerial meeting concerning the development of the Soil Protection Act (MICOB 1976). A few months after this meeting, in April 1976, the report 'Further underpinning of the need to develop an overarching soil policy' appeared and was sent to Parliament to further support the development of the overarching Soil Protection Act. In this report, already mentioned in Section 4.1.2, the fundamentals of soil protection were formulated and it contained the following elaboration of the concept:

> To maintain the capacity of soil to fulfill various functions, especially for the preservation of humans, animals and plants, now and in the future- is at the core of soil protection and can be referred to as striving after multifunctional soil quality.
> (Zeilmaker 1976)

Several attempts were made to operationalise the concept of multifunctionality and distinguish the different functions of soil that had to be maintained. In the first appendix of the document the following four functions were distinguished.

- Ecological-geomorphologic function (Soil as the carrier of ecosystems, vegetation, soil fauna and – flora)
- Agricultural function
- Water supply (drinking water, agricultural, industrial and ecological use)
- Mining and energy

(Zeilmaker 1976)

The formulation of the first function (ecological-geomorphological function) reveals the professional background (geology) of the main author of the report. In later typologies of functions, this function is generally referred to as ecological function. The above four functions show that soil was considered a resource for economic development and ecosystem functioning. In the Explanatory Memorandum of the Soil Protection Act (Min.V&M 1980), the functions were formulated slightly different and grouped into two categories.

User function
- Carrier function
- Food production
- Groundwater
- Mineral supply

Ecological and aesthetic function
- Support ecosystems
- Clean soil (in relation to ingestion)
- Nature and landscape

(Min.V&M 1980)

In that document, the ecological function was given priority in soil protection. It was considered the crucial and most vulnerable to protect the soil ecosystem against irreversible adverse effects. In the Preliminary Soil Policy Plan, the functions were regrouped into four (Min.VROM 1983).

> Alongside the general aims of environmental policy, a specific guiding principle for soil is that in principle soil should maintain the capacity to properly serve various possible functions, so-called multifunctionality of soil. To preserve these functions, essential characteristics of soil should be protected.
> (Min.VROM 1983)

These functions were:

- Carrier function
- Water storage
- Production function (including agriculture and mining)
- Ecological function

(Min.VROM 1983)

The three subfunctions of the ecological function from the Explanatory Memorandum of the Soil Protection Act were regrouped into one. Mineral supply was grouped with the agricultural function into 'production function'. This grouping and regrouping in the subsequent publications had limited significance; as it had been already been explicated that the ecological function was considered most vulnerable, and therefore, soil protection policy would have to protect this function. The other functions were of less concern. This selection of the ecological function, as the function of importance for the development of soil policy and for the principle of multifunctionality was crucial to the development of soil policy and soil research.

As a guiding principle for policy, the concept of multifunctionality was well received. It linked up to the general principles for environmental policy in the 1970s (see (Broekhans 2003) for an explanation of these principles in Dutch environmental policy). In addition, it was specific enough while providing sufficient degrees of freedom for science and policy to be united under this umbrella. Its vagueness was, at that time, crucial to facilitate scientific research (the Netherlands Integrated Soil Research Programme (see Section 4.1.4) and further policy development (CRMH 1991). The concept itself in its initial vagueness was successful as a means to speed up and set the course for further policy development and bring together science and policy. However, this role a soon ended, and consequently the concept should have been specified more precisely after this initial vagueness. I believe that the criticism that the operationalisation of the policy concept suffered from its own vagueness is just (see critical reports, for instance by CRMH, see also a discussion on this in episode 2). Now, the operationalisation was shaped only by the development of soil quality standards. The soil quality standards developed in this first episode became important instruments as they gave meaning to the principle of multifunctionality. Standards were perceived as important instruments in soil policy. This view was explicitly formulated in the Memorandum Environmental Health Standards (Min.V&M 1976b). In the same policy document, the scientific underpinning of these instruments was explicitly mentioned. Section 4.1.4 describes the efforts to develop scientific knowledge for soil quality standards in this first episode.

4.1.4 Scientific knowledge for soil quality standards

Already in 1972, at the onset of soil policy, we find a plea for scientific research in the Priority Memorandum on the Environment (Urgentienota milieuhygiëne) (Min. V&M 1972), a seminal policy document, setting out the urgent issues in environmental policy. This knowledge was required to develop environmental quality standards:

> These abstract instruments should be based on scientific knowledge and the intensification of scientific research is given high priority. This should result in an increased understanding of 'nature, scale, and impact' of pollution as well as the development of 'clean technologies'. In addition, scientific methods should be developed to evaluate what is acceptable and what not, to be able to interpret the vast amount of qualitative and quantitative data that has been produced.
> (Min.V&M 1972 p.51)

This plea for scientific knowledge was directly related to the development of policy instruments (notably, standards). For standards to be adequate instruments it was considered essential to increase knowledge. The required increase in knowledge was specified as:

> (1) drawing up an inventory of nature, scale, intensity and duration of pollution. In addition, (2) stock must be taken of the biological characteristics of the environment, ecosystems and species. A complete picture must include physical, chemical as well as biological (ecological) aspects.
> (Min.V&M 1976b p.29)

With respect to knowledge underpinning standards, the following two points were brought forward:

> [Firstly].It is not always possible to answer the question whether sufficient knowledge is available objectively. Secondly, even if it is acknowledged that there are gaps in knowledge, it can still be desirable to develop standards.
> (Min.V&M 1976b p.29)

This formulation provided the condition to proceed with deriving standards and act pragmatic in case the scientific basis could not be provided. This is a crucial quote as it implies that scientific knowledge could be waived for the sake of moving forward the train of policy development. Scientific knowledge could contribute to the development of standards (and therefore, the development of policy), but not halt or delay it. This is related to the remark made by the VCRMH in its advice (VCRMH 1977) that was mentioned in Section 4.1.2 about the fact that standards development should be based on available scientific knowledge, awaiting the results of the research programmes.

In the 1980s, available knowledge on soil had a strong physical, chemical and geological inclination. In the research agendas the abiotic part of soil was the focal point.

> It is worthwhile to note that physical, physicochemical and chemical processes have received much more attention in the past compared to biological processes. This might be related to the higher complexity of processes within and among living systems and organisms. We regret this gap in knowledge on these processes now that protection of the environment calls for quantitative information on these biological processes.
> (De Haan 1986 p.18)

The development of scientific knowledge on soil, and the effects of soil pollution was organised in research programmes that were to a large extent funded by the Ministry of Public Housing, Spatial Planning and the Environment. It is important to keep in mind that the Ministry deliberately steered the development of scientific knowledge towards serving its policy goals. What the Ministry sought to do was to develop a body of regulatory scientific knowledge. It did so by developing research programmes, but also by actively establishing connections with scientists. The establishment of the TCSP is the clearest example. The direction in which the scientific community was being steered is shown by the following list of the programmes funded by the Ministry of Public Health and the Environment.

Soil Protection (1977-1983)

The programme was funded by the Ministry of Public Health and the Environment and lasted from 1977-1983. The expenditure of the research programme could be estimated around €10 million. This research programme was meant to provide basic knowledge and insight concerning the most important elements of soil pollution. Such knowledge was required to prepare effective government policies and instruments concerning soil protection. The programme was meant to fund research projects that would provide knowledge to support the further development of the overarching Soil Protection Act (Min.V&M 1976b p.3-4).

Until then, research concerned human activities in and around the soil like mining, construction works and agriculture (Min.V&M 1976a p.3). The document gave examples of the agricultural and civil engineering research that took place in various organisations such as the Institute for Soil Fertility (IB), the Institute for Drinking Water Supply (RID) the Study Centre for Road Construction (SCW) and university departments. It was argued that this knowledge would have to be supplemented with a research programme providing basic knowledge about the soil ecosystem as well as about effects of human activities on the soil ecosystem. The agenda of the programme reflected this need to increase factual knowledge on effects on the soil system and on measurements and techniques. An example of such project was the measurement of concentrations of heavy metals in relatively undisturbed areas. This project provided the data used to calculate the reference values (Edelman 1984).

As part of this research programme, a proposal for a follow-up programme was written and published in 1984 (De Kruijf et al. 1984), calling to attention that soil ecology was a forgotten but important scientific field for future developments of soil policy. Given the selection of the ecological function the report recommended to develop a coherent research programme with a focus on soil ecology. The Advisory council for research on nature and the environment (RMNO) was identified as the appropriate council to formulate the outline of such programme. In March 1985, the (RMNO) published its analysis (commissioned by the Ministry of Education and Research) in a report entitled Grounds for Concern (RMNO 1985). That report first and foremost provided an overview of the results and achievements of soil research until then. That overview was considered the prelude to a chapter in which the outline of a large research programme was given, with an agenda of eleven research themes. The principle of multifunctionality provided the conceptual background for the programme. The first theme considered the collection of basic knowledge about the soil system: background values of substances, a typology of soil, the functioning of soil life. The second theme concerned knowledge about the effects of pollution. The third theme concerned treatment techniques and effects. The fourth up to and including the tenth theme concentrated on waste production and specific effects of specific waste. Finally, the eleventh theme was 'research on administrative issues'. The 'Grounds for Concern' report provided the justification for the large programme Netherlands Integrated Soil Research Programme (SPBO) that started in 1986. The 'Grounds for Concern' report used the concept of multifunctionality to identify additional issues for research: natural recovery of soil and the self-cleaning potential of soil as well as the translation from soil processes and soil characteristics to multifunctionality (Min.O&W et al. 1986 p.19). The development of this knowledge was considered important to the development of soil quality standards. These standards in turn were considered important to the operationalisation of soil policy as formulated in the Preliminary Soil Policy Plan and in the Soil Protection Act.

At the same time, another programming report was published by a committee of scientists established by the National Council for Agricultural Research (NRLO) together with the Foundation for Biological Research (BION) sketching the outlines of a research programme (Soil Biology) (NRLO 1984). The committee consisted of scientists that were mainly associated with agricultural research. In the programme document, the development of the research programme was legitimated by reference to the budget of the Ministry of Education and Science, and the Ministry of Agriculture and Fisheries. The programme document also referred to the Preliminary Soil Policy plan (mentioned in Section 4.1.2) where the need to develop a body of knowledge concerning the ecological function of soil was explicitly formulated. Interesting about this programme is that it was supported by the Ministry of

Agriculture and Fisheries and written by scientists conducting research related to agriculture. In Section 4.1.1, which described the development of the legal framework for soil policy, it was explained that the Ministry of Agriculture and Fisheries was not supportive or cooperative concerning the development of the overarching Soil Protection Act by the Ministry of Public Health and the Environment. We will see in Chapter 5 that scientists associated to agricultural research conducted most of the work for the development of the soil quality standards for environmental policy.

Soil Ecology (1985)

In 1985, the research programme Soil Ecology was started, anticipating the start of the Research Programme Soil Research (SPBO) later that year. The programme was coordinated by the Ministry of Education and Research and was meant to bridge the gap between the previous and following research programme.

Netherlands Integrated Soil Research Programme SPBO (1986-1994)

Based on the analysis in 'Grounds for Concern' a large, initially four-year, research programme was launched in 1986, funded by the Ministries of Education and Science, Public Housing, Spatial Planning and the Environment, Agriculture and Fisheries, and Transport and Waterworks. Its budget amounted to €24 million. The programme was presented to Parliament in April 1986 (Min.O&W et al. 1986), and officially started at that date. The eleven themes mentioned in the above mentioned report 'Grounds for Concern' were regrouped and reduced to five themes that have been modified over the years: A) Theory building, synthesis of data, basic knowledge, B) Research into effects, C) Basic knowledge into resilience of the soil ecosystem D) Risk analysis and underpinning of standards, E) Development of techniques for treatment and prevention (Min.O&W et al. 1986 p.8; Rogaar 1993). The fourth theme, risk analysis and the underpinning of standards, would have to provide the knowledge required to take further steps in the development of effect-oriented standard setting. Besides research development, the programme committees and research office had the task to strengthen the knowledge infrastructure and to connect them to international research.

The ambitions for the programme were twofold: the development of basic knowledge about soil and soil systems, and the development of knowledge to further soil policy. Such double ambitions often turn out to be problematic; not only because basic knowledge might be required before any more applied knowledge can be developed and formulated to further policy, but also because the scope of these two types of knowledge differs. It could be argued that the double ambition of SPBO is a forerunner of the development of the target and intervention values Chapter 6. The tension between different types of knowledge begins to build up in

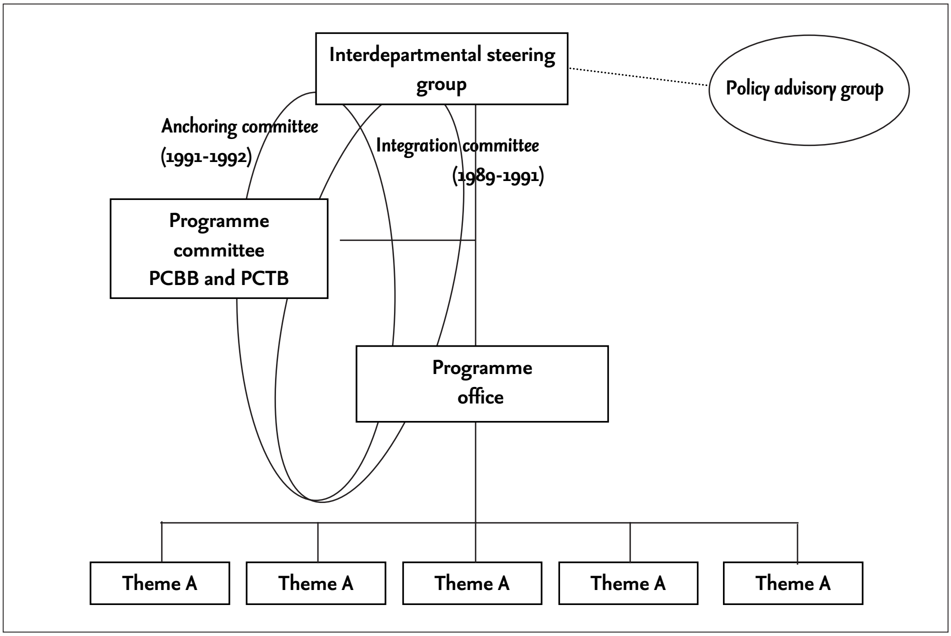


Figure 4.1.1 Organisational structure of SPBO. After (RMNO 1993; SPBO 1993).

this first episode, runs through the second episode, and culminates in the demarcation of regulatory and research science in the case study on the development of target and intervention values.

In Figure 4.1.1, the organisational structure of the programme is given. It is a complex structure that reflects the complexity of the double ambition of the programme. In the steering group, four ministries were represented and at some stage a policy advisory group was established to council the policy elaboration. This group consisted of one representative per Ministry. Two programme committees were established: the PCBB (Programme Committee Basic Knowledge Soil Research) and the PCTB (Programme Committee Technology Development Soil Research). Both committees consisted of scientists. The PCBB guided the development of the basic knowledge (roughly themes A and C), whereas the second programme committee PCTB, mainly guided the development of techniques for treatment and prevention. Both committees were actively involved in the peer review of research proposals. In addition, an anchoring committee was established to ensure and strengthen the relation between research and soil policy and to prepare a proposal for the continuation of a new research programme as a follow-up of the SPBO. This committee consisted of members of both programme committees, the programme office and two scientists outside the organisation of the programme. The programme was prolonged until 1994 and evaluated in 1993 by the RMNO (1993) and by the KNAW (Dutch Royal Academy of Science and Arts) (KNAW 1993). These evaluations are discussed in episode 2.

4.1.5 Crafting a network of policymakers and scientists

In this first episode, while getting soil policy off the ground and increasing research efforts, the Department Soil at the Ministry considered it crucial to create

> …a coalition of engaged and friendly scientists
> (Interview quote policy staff member at the time)

Compared to other environmental compartments of water and air and related policy fields, (such as agriculture) the development of quality standards was lagging behind with regard to the soil compartment. In addition, research infrastructure (i.e., institutes) already existed for the other environmental compartments, air and water, facilitating scientific knowledge to underpin policy. The Ministry of Infrastructure and Waterworks had its institutes (RIZA, RID, RIKZ). The Ministry of Agriculture and Fisheries had built up a scientific network at the Wageningen Agricultural School[8] and the National Agricultural Research Institutes. For the relatively new policy issue of soil protection and pollution, scientists had to be cut loose from their ties to the Ministry of Agriculture and Fisheries. As was explained in Section 4.1.1, the Ministry of Agriculture and Fisheries claimed to have the technical knowledge on soil and soil quality in a letter to the Ministry of Public Health and the Environment.

In this first episode the relation between science and policy intensified. The development of multifunctionality and the importance given to the developments of standards indicating good soil quality played a decisive role. These standards had to be based on scientific knowledge. That knowledge was lacking at the time, and large research programmes were being developed. The research funds in the Research Programme Soil Protection, later continued as the Netherlands Integrated Soil Research Programme SPBO (see Section 4.1.4), facilitated this, as did the establishment of the TCSP. The committee became effective in a preliminary setup in 1985. This committee played an important role in the labelling of usable knowledge for the reference values, as we will see in Chapter 5. The committee consists of scientists and experts on soil quality who advise the ministry on technical aspects of soil policy.

4.1.6 The institutional context in episode 1, an integration

The above account of what qualifies as 'getting started' provides the institutional context within which the labelling of usable knowledge in the first case study was performed. Between 1971 and 1988, soil policy gained a certain position within

8 Current name: Wageningen University environmental policy. In 1971, the Ministry of Public Health and the Environment was established. In the same year a draft act on soil pollution was send to the Lower House. In the following year, 1972, the Soil Sector was established within the Ministry. In 1974, a working group was installed to further the Soil Protection Act. In this first episode, soil policy established a position relative to other environmental policies and relative to different flanking policy fields, notably agriculture, in which soil quality has long since played a role. This process of acquiring a policy position was prominent and successful. The acceptance of the Soil Protection Act in 1987 was a landmark for soil protection policy. Underlying the success of soil policy was the principle of multifunctionality. This principle was anchored in the Soil Protection Act.

Great efforts were made to establish contacts between science and policy to underpin the further development of soil policy. The establishment of research programmes, funded by different Ministries and the establishment of the TCSP are illustrations of this.

As explained in Chapter 3, the institutional context could be interpreted as consisting of three dimensions. In the first section of this chapter, it was explained that events, achievements and developments could be 'assigned' to different dimensions. What follows from the explanation there is that the Soil Protection Act and the Interim Soil Pollution Act are at the regulative dimension of the institutional context in this episode. These two legal frameworks provided clarity about responsibilities for soil quality. They also made clear which activities were prohibited as they endangered the multifunctional quality of soil. A focus on the normative dimension reveals the continuous dispute of competence between the ministries over the development of this act. Besides this competence issue between the ministries, also the relations between the different sectors within the Ministry of Public Housing, Spatial Planning and the Environment, representing the different environmental compartments, played a role. An added element was that a tighter relation between science and policy had been created by establishing the TCSP. The research programmes developed in this first episode further contributed to the closer interaction between science and policy.

On the cognitive dimension, the principle of multifunctionality stands out. Attempts to operationalise it had produced somewhat different typologies of functions. However, the exact typology was not that relevant, as the ecological function was already selected as most vulnerable. This selection paved the way for ecological research programmes and for ecological soil quality standards. In Chapter 5 a first attempt to develop such standards is studied.

It can be argued that in this episode the foundation was laid for regulatory practice. Scientists and policymakers were in close contact; staff members at the newly established department were (besides lawyers) scientists with a background in soil science, geology or ecology. What played an important role was the shared belief that standards were important instruments for the development and implementation of soil policy, together with the belief that these standards had to be based on scientific knowledge.

Table 4.1.1 summarises the institutional context in this first episode. As Chapter 3 explains, these three dimensions are expected to determine what arguments are used to label usable knowledge for the development of standards developed in this episode; the reference values. This labelling of usable knowledge is the subject of the first case study described in Chapter 5.

Table 4.1.1 The three dimensions of the institutional context in the first episode. For each dimension critical events, achievements and developments explained in the text above are given in the table.

Regulative	• Interim Soil Pollution Act (1983)
	• Soil Protection Act (1987)
Cognitive	• Multifunctionality
Normative	• Carving out a department (sector) for soil quality at the Ministry of Public Health and the Environment
	• Disputes between ministries over authority to regulate soil quality
	• Establishing the Technical Committee on Soil Protection
	• Soil research programmes (Soil Protection, Soil Ecology, Netherlands Integrated Soil Research Programme SPBO)

4.2 Reflection and renewal: 1989-1994

Section 4.1 described the first episode. In 1989 a new episode started with the introduction of the risk approach and new scientific concepts to underpin soil policy. With that, the number and heterogeneity of actors involved also increased. In the previous episode soil policy was established and connections between science and policy were made. The acceptance of the Soil Protection Act (1987) and the Interim Soil Pollution Act (1983) were crucial to the position of soil policy in that episode (regulative dimension). Conceptually, soil policy, as well as the standards derived in the first episode (reference values), was based on the principle of a multifunctional soil quality, a principle widely accepted in environmental policy, as it connected to basic environmental policy principles as described in the Priority Memorandum on the Environment (Urgentienota Milieuhygiëne). Through the development of the standards, interdependence between science and policy grew and was manifested by the establishment of the TCSP and the establishment of large government-funded research programmes, notably the Netherlands Integrated Soil Research Programme (SPBO). Together with the developing relation between science and policy, the rivalry between the different ministries concerning the issue of authority characterised the normative dimension of the context within which the reference values were developed.

In the years following the sensational disclosure of heavily polluted sites in the early 1980s (see Chapter 1), the number of potentially polluted sites increased steadily. The size of the problem (of polluted soil) increased and outnumbered the estimations used to legitimise government expenditure for soil treatment. A major problem that began to trouble the policy field was its stagnating performance; new cases of polluted sites were reported regularly, while the treatment of sites was far more expensive and technically far more complex than reckoned with. The problem increased rather than decreased. This called for reflection on past performance, on the fundamentals of soil policy and urged for improvement and renewal. The reflection and renewal of soil policy produced a constant flow of reports, analyses, advice and assessments. In several of these reports, the ambitious principle of multifunctionality, the guiding principle of soil policy, came under attack. Initially, proposals for the reduction of the size (and costs) of soil pollution concentrated on the streamlining of procedures (Stuurgroep Tienjarenscenario bodemsanering 1989). Later, new concepts were introduced; the risk approach (Min.VROM 1989b), the active soil management approach (Werkgroep Bodemsanering 1993), and finally the function-based approach. Besides this criticism on the cognitive concept underlying soil policy, criticism on the role of national government was elicited by the Association of Netherlands Municipalities (VNG) when the Interim Soil Pollution Act was integrated into the Soil Protection Act (VNG 1992).

At the same time, amidst these reconsiderations, progress was made with the promise of effect-oriented soil quality standards. In the previous episode the reference values for soil quality, as a first attempt to derive ecological effect-oriented standards had been developed and published in 1988. The suggestions for improved effect-oriented standard setting (Denneman et al. 1985) and presented at the Symposium on Soil Quality in 1986 (VTCB 1986c), got more and more hold as results from the research programme SPBO became available. The introduction of the risk approach in environmental policy coincided with this and made a number of initiatives fit together resulting, amongst other deliverables, in new standards. The detailed development of effect-oriented standards in this episode is the subject of Chapter 6.

4.2.1 Tightening up and involving more actors

The fractioned, stepwise development of the legal framework for prevention and treatment of soil (Soil Protection Act in 1987 and Interim Soil Pollution Act 1983) was perceived as a potential threat to the coherence of policy. In the first episode the Preliminary Soil Policy Plan was prepared by the ministry to bridge the gap until the acceptance of the Soil Protection Act. In the second episode, the Minister of

Housing, Spatial Planning and the Environment installed a steering group in which the Association of the Provinces of the Netherlands (IPO), the Association of Netherlands Municipalities (VNG) and the Ministry of Public Housing, Spatial Planning and the Environment (VROM) were represented. Similar to the Preliminary Soil Policy Plan, this steering group had to produce a future perspective for soil policy. The difference between that Preliminary plan and this initiative is that this Steering Group consisted of a number of actors outside the ministry, representing the actors that played a significant role in the implementation of soil policy. This difference typifies the first and second episode; whereas in the first episode, the ministry set the contours for soil policy, asking advice from the VCRMH, Health Council, and TCSP, in this second episode, actors outside the Ministry were more explicitly involved in setting the contours for soil policy. The steering group '10-Year-Perspective' was asked to produce a scenario for the ten years of soil policy ahead. Its report was produced in 1989 (Stuurgroep Tienjarenscenario bodemsanering 1989) and was the herald of a new stage in soil policy development in terms of the actors involved in decision-making and standard setting. Underlying the advice were inventories of potentially polluted sites by the provinces, which had assessed the size of the problem of soil pollution. These inventories suffered from methodological difficulties (criteria for assessments differed per authorised authority, the mobility of substances, the heterogeneity of the soil, and the technical complexity of taking and measuring soil samples) allowing only a rough estimation of the size of the cleanup operation. Irrespective of these methodological differences, the actual size of the problem turned out to be much larger than assumed in the early 1980s when the soil treatment operation started:

> Evidently, 6,000 sites will have to be treated. About 100,000 industrial sites may be polluted in which case they have to be treated and a still unknown area requires measures while it is impossible to estimate the costs of prevention of further pollution.
> (Stuurgroep Tienjarenscenario bodemsanering 1989 p.35)

At the start of the cleanup project, total costs were estimated at €0.5 million. Until 1988, approximately 750 sites were treated at a total cost of already slightly over €0.5 million, provided by national government. Costs of privately funded treatments were estimated at similar amount. The financial burden of soil pollution became high, unacceptably high according to some. The steering group explored ways to reduce this burden. Would it be a matter of renewing the guiding principle of multifunctionality, which had led to such stringent standards for cleanup? Would it be a matter of loosening the priority given to the ecological function as the most vulnerable? Alternatively, administrative and legislative procedures for cleanup and sanctioning for pollution could be revised, the legal sanctions for pollution could be increased, and making polluters pay for the treatment. The steering group was clear in its advice to maintain the underlying principle of multifunctionality. It argued that loosening the principle of multifunctionality (and replacing it by principles resulting in less strict targets for cleanup) would indeed reduce the size of the problem and hence the costs in the short term, but it would basically shift the problem forward without solving it, increasing the problem in the long run. The steering group instead advised to search for financial and administrative measures to increase the efficiency of the soil remediation operation. For instance, the ministry was urged to be more specific about the location-specific conditions under which ICM (isolation, containment, monitoring) measures would do (see Section 4.1.1 on the Soil Protection Act). Furthermore, and in the same line of reasoning, the steering group stressed the importance of further development of preventive measures and to be stricter on 'the polluter pays principle' as a means to reduce the financial burden for the national government. The steering group also lobbied for the identification of the polluter, and for a shift in the role of the government from financial backer to a guardian of soil quality. The suggestions in the advice triggered the Ministry to install a working group in which the same actors: the Ministry of Public Housing, Spatial Planning and the Environment, the Association of the Provinces of the Netherlands (IPO), and the Association of Netherlands Municipalities (VNG), were represented (in the text referred to as the Welschen Working Group, named after its chairperson) (Werkgroep Bodemsanering 1993). The Welschen Working Group's task was to translate the strategic advice of the '10 Year Perspective' Steering Group into practice and to propose solutions for operational problems. The Welschen Working Group prepared an advice and suggested a variety of renewals of soil remediation practice under the heading of 'active soil management'. This 'active soil management' was in fact the formulation of an approach already applied in practice. The working group summarised active soil management as:

> The total of activities in an area geared towards adequate and effective management of structural pollution and its consequences.
> (Werkgroep Bodemsanering 1993 p.22)

Activities like building and construction works should be used as an opportunity to gather knowledge on the soil system. This knowledge should be collected in, e.g., maps and databases to be available to all parties with an interest in soil quality. Compared to the '10 Year Perspective' Steering Group's report, the Welschen Working Group's report considered the option to renew the cognitive dimension and to reconsider the concept of multifunctionality. The concept of multifunctionality might have to be replaced by a concept facilitating a more pragmatic approach to deal with the large number of polluted sites. The latter report included a scheme to prioritise the treatment of sites. This approach was later called the 'Urgency classification scheme'[9].

9 Basically, the classification is used to prioritise and set up a working programme for the remediation of polluted sites. It is based on an assessment of the actual and potential risk to ecosystems and human health.

In this report, new remediation techniques like on site cleanup techniques[10], were promoted. In general, these techniques are less expensive because they do not require transport and storage of polluted soil while results are promising. In situ techniques enable treatment 'on the spot' and fitted in well with the concept of active soil management. The development costs of these techniques were foreseen to be high and, correspondingly, it was advised to develop a research programme. In 1994, a new research programme (NOBIS) was set up (see episode 3 for more details on this programme). The reports of the steering group and the working group placed soil remediation in a different, more pragmatic, perspective; besides environmental interests, economic and societal interests would have to be included in the assessment of soil quality and in determining the remediation target[11].

4.2.2 The principle of multifunctionality

In this second episode the principle of multifunctionality as the guiding principle for soil policy and for the development of soil quality standards came under attack.

In 1994, the Interim Soil Pollution Act was integrated into the Soil Protection Act. This development triggered the Association of Netherlands Municipalities (VNG) to formulate and publish its vision on soil policy, treatment and pollution. (Handling soil remediation, the vision of municipalities; Omgaan met bodemsanering; een gemeentelijke visie, 1992) (VNG 1992). Incorporation of the Interim Soil Pollution Act would make soil treatment subject to the principle of multifunctionality as it was formulated in the Soil Protection Act. The Soil Protection Act contained stricter targets for remediation compared to the Interim Soil Pollution Act. Municipalities were concerned about this as it would increase costs and reduce the progress of remediation. The Association of Netherlands Municipalities (VNG) criticised the fact that the guiding principle of multifunctionality was being applied to all polluted sites, irrespective of their present or future land use. The VNG argued that for local, concentrated, hot spots of pollution – point pollutions that are relatively easy to locate, assess and treat – the approach of multifunctionality might be effective. For the more common cases of diffuse pollution, it was just not feasible to apply the principle of multifunctionality. As the VNG argues, this would call for the use of ICM[12] measures (see previous episode or a short description of ICM). ICM measures mean that the pollution is not treated but isolated, contained, and monitored. In these cases, the principle of multifunctionality is set aside, which

10 On-site remediation.

11 This is one of the central issues of policy renewal in the third episode.

12 Isolation, Control, Monitoring. This was an alternative treatment to be used if specific local conditions (technical, financial, environmental) were met.

in general results in less strict targets for treatment. Using ICM measures too often would erode the strategic principle of multifunctionality, and, as the VNG argued, undermine it. The VNG came up with an alternative, operational approach. Instead of adopting generic standards and policies, the VNG proposed to differentiate between functions of soil and established targets for cleanup related to the current function (or land use) and to the background values (concentration of substances already present in relatively undisturbed areas, due to natural occurrence or to diffuse deposition). Their reports (VNG 1992; Werkgroep Bodemsanering 1993) pointed out that for the development of effective and efficient soil policy, location-specific conditions probably mattered more than generic conditions. As such, this was a criticism on the guiding principle of multifunctionality that was explicit about generic soil quality; soil quality had to be similar (taking into account differences in soil type) throughout the country, irrespective of actual land use. With this document, the VNG interfered with the development of policy and standards that, until then, was dominated by national government, i.e., the Ministry. The report also implied criticism concerning the government's dominance and it turned out to be the prelude to the reconsideration of the roles of the different governments that came into full force in the third episode.

The ministry received the critical message and responded with a document: Location-specific circumstances (Notitie locatiespecifieke omstandigheden) (Min.VROM 1992), in which the possibilities to apply location-specific measures (qualifying for ICM measures) were explained in more detail. This was an attempt to call a halt to the erosion of the principle of multifunctionality as predicted by the VNG. In addition the Ministry formulated a further underpinning of the generic reach of soil policy and standards.

> Generic principles cannot be made specific to the degree that they can be applied in any possible case. First, such differentiation may lead to unbridgeable scientific problems, as no models are at hand that can adequately cover the variety of location-specific circumstances. Secondly, such framework of standards would be obscure and little user-friendly. Thirdly, very detailed and differentiated regulation and standard setting would be in contrast to the effort for deregulation and decentralisation.
> (Min.VROM 1992 p. 8)

In this text, the tension between generic standards and effect-oriented policy was explained; the generic character concealed in standards conflicts with the local and actual manifestation of effects. Having identified this inherent inconsistency, the document continued and provided two strategies to solve this: uniformisation of criteria and uniformisation of procedures

> This [refers to text above, AS] is not to say that uniformisation inevitably cedes to flexibility. Different uniformisation strategies are thinkable that still allow for location-specific approach. Uniformisation can apply to criteria for decision-making.
> (Min.VROM 1992 p. 8)

The importance of the policy document is twofold. Firstly, it was acknowledged that there is an internal inconsistency between effect-oriented policy and the use of generic standards as instruments. Secondly, it was acknowledged that this inconsistency would have to be resolved. With this document, the criticism on the guiding principle of soil policy was shifted towards a criticism on the application of that principle to developing standards. Implicitly, the intimate connection established in the first episode, when the principle of multifunctionality was applied to derive standards (the reference values), was criticised. This issue; the differentiation between guiding principles for soil policy and guiding principles for standard setting was touched upon in the annual report of the TCSP in 1989. That annual report of the TCSP addressed the fact that policy principles can be interpreted in a hierarchical order from concrete to abstract. At the highest level, policy principles are ethical, referring to a deeply rooted notion. At the intermediate, strategic, level we find reference to principles that translate the ethical principles to guidelines for policy on a specific issue. Finally, there is the operational level, which has policy principles for concrete policy actions, programmes or projects. The principle underlying the reference values is a strategic one, translated from the sustainability notion. This implies that the reference values are operationalisations of strategic policy principles, and therefore should be used as such. The danger of using reference values as operational values is that the principle of multifunctionality might be abandoned, just because the standards have not been chosen well. The policy principle at the strategic level that is meant in the TCSP annual report is the principle of multifunctionality.

In the midst of these reflections and proposals to revise not only the guiding principle, but also the organisation of soil policy-making, there was another development that deeply affected the course of soil policy and standard setting. It concerned the development of a new approach to environmental pollution; the risk approach. This approach was introduced as early as 1989, prior to the analyses discussed here. However, it did not interfere with the developments concerning multifunctionality, other than that it provided a concept with the potential to guide soil policy through this second episode. In that sense it took over the role of the principle of multifunctionality.

4.2.3 The risk approach

Besides the reflection on past performance, the publication of the risk approach marks the beginning of the second episode. In 1989 it was introduced in Dutch environmental policy in 'Premises for Risk management' (Min.VROM 1989b), a seminal document attached to the National Environmental Policy Plan (NEPP) (Min.VROM 1989a). Environmental policy and standard setting since 1989 were permeated with the concept of the risk approach. Characteristic of this concept was the notion that societal development has unavoidable adverse effects. The risk approach included assessment of the extent, reversibility and acceptance of these adverse effects, and the development of strategies to minimise and manage these effects. The risk approach was developed to be the

> …ruler for effect-oriented environmental policy. Risk criteria indicate the upper (maximum tolerable risk) and lower (negligible risk) limit.
>
> For substances in the environment, the document states that the upper limit is reached when the concentration of a substance equals the calculated concentration of the substance at which 95% of the species present in an ecosystem are protected. The negligible level equals 1% of the upper limit.
> (Min.VROM 1989b)

The risk approach translated into two concentration levels of potentially toxic substances: the upper and negligible risk levels. The details of this translation are discussed in more detail in Chapter 6, which analyses the labelling of usable knowledge for the calculation of these upper and negligible levels. The risk approach distinguished between the effects on human health and effects on ecosystems. For the calculations of risks to human and ecosystem health, different calculations and methods were used. The most vulnerable of the two determined the risk level. The determination of effect levels for human health has its own scientific and policy background. It is not treated in further detail here. The notion of risk combined well with statistical techniques, because probability and uncertainty are at the heart of statistical techniques. Statistical techniques flourished and were used to develop models to calculate maximum acceptable or tolerable levels of substances (extrapolation models, regression techniques). What has become known as the 'risk approach' in Dutch environmental policy comprised policy concepts as well as the scientific models applied to calculate standards like target and intervention values (see Chapter 6). The risk approach and its operationalisation in 'upper and negligible risk levels' was criticised by the Central Council on Environmental Protection (CRMH) in 1992 (CRMH 1992). The CRMH disagreed with the concept of negligible levels and its arbitrary operationalisation as 1% of the upper risk level.

According to the CRMH, setting a minimum level invoked filling up pollution until the minimum level. As an alternative the Council suggested to apply the ALARA principle (As Low As Reasonably Achievable). The CRMH furthermore objected to the operationalisation of the upper risk level as 95% species protection level. According to the CRMH it was unclear what this exactly referred to. The CRMH qualified its critical comments on available knowledge as follows:

> …taking into consideration our critical comments to the 95% standard, for the moment it seems to be wise to 'assess' the state of ecosystems by using indicator species, taking into account that at present the technical means and scientific knowledge to do better are lacking.
> (CRMH 1992)

This proposal to use indicators rather than standards could be interpreted as a signal that the CRMH was critical about standards as instruments in effect-oriented environmental policy favouring the use of indicator species. However, upon close reading, the CRMH proposes indicator systems as a second best option to be applied in case of insufficient knowledge to develop standards. This critical comment of the CRMH is similar to its comments on the Memorandum Environmental Health Standards written down by the VCRMH in 1977 (VCRMH 1977). In 1977 the VCRMH was critical about the implicit assumption that sufficient scientific knowledge would be available for the development of the environmental quality standards that were announced in 1976. More than a decade later, the CRMH was still critical about the suggestion to avail of sufficient scientific knowledge for the development of standards for soil quality. In addition, the CRMH pointed out five more problems in the risk approach:

1. *Because of the technical complexity of statistical extrapolation methods, it is difficult to make an informed selection of the best model.*
2. *The assumption that species protection safeguards ecosystem protection fully ignores the essence of ecosystems; the relations between species and populations.*
3. *The translation of data from laboratory to field situations is problematic.*
4. *There are insufficient toxicity data and test methods to apply the risk approach to terrestrial systems.*
5. *Indirect effects and long-term effects of substances are not taken into account.*

The introduction of the risk approach changed environmental policy in many ways. It was a revolutionary new development in environmental policy. In contrast to what has been said about the role of scientific knowledge in the development of standards in the previous episode (Section 4.1.4 and 4.1.5), in this episode scientific knowledge is indeed very important to provide legitimacy to the new policy course. Collingridge and Reeve (1986) argued that the role of science in incremental decision-making is limited. In this second episode the revolutionary development in policy did make scientific knowledge a very important source for legitimation. Science mattered very much to the development of standards based on the risk approach. Chapter 6 will point this out in more detail. The introduction of the risk approach affected the cognitive dimension, as well as the normative dimension. It was introduced as the umbrella to harmonise environmental quality standard setting for all environmental compartments, thereby changing the relations between environmental policy fields.

4.2.4 Developing and evaluating a (regulatory) science basis

The 95% species protection level in the definition of the risk approach as given in Section 4.2.3 stemmed from the work on species sensitivity distributions (SSDs). The use of SSDs as a scientific basis for the calculation of risk levels for ecosystems rested on three assumptions. First, the ecological function of soil is a derivative of the functioning of the soil ecosystem. The second assumption was that structure of ecosystems determines the functioning of ecosystems. In bringing to the fore this assumption, the then prevailing paradigm about the relation between ecosystem functioning and structure was introduced. The third assumption underlying species sensitivity distributions was that whenever the species composition is not seriously affected, there is no serious risk to the structure of the ecosystem. Figure 4.2.1 summarises the line of reasoning. The problem of operationalising 'serious risk to functional characteristics of soil' has been shifted towards operationalising serious risk to the species composition of soil ecosystem.

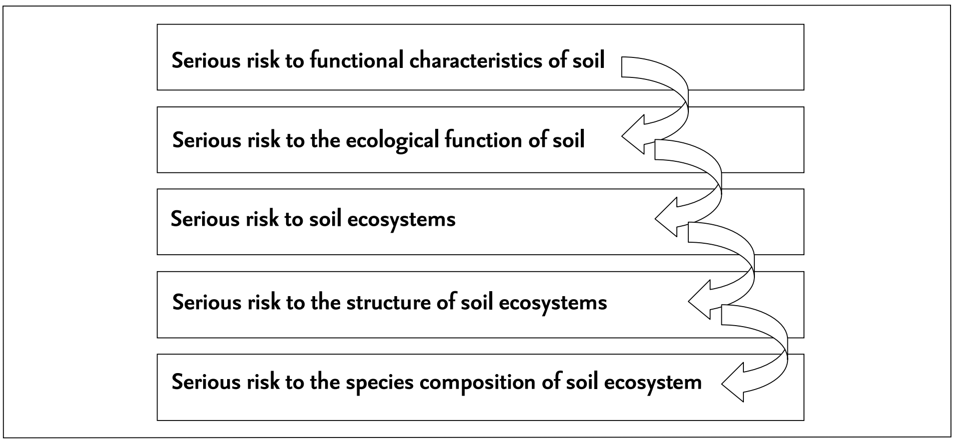


Figure 4.2.1 Operationalisation of 'Serious risk to functional characteristics of soil' (Denneman and Van Gestel 1990 p. 7).

Netherlands Integrated Soil Research Programme; SPBO

The models to calculate species sensitivity distributions were developed under the flag of the Netherlands Integrated Soil Research Programme (SPBO) and the project Setting Integrated Environmental Quality Objectives. Both programmes conducted or commissioned research projects, but had a wider impact than the mere generation of research results. In the previous episode, SPBO was launched as a major research effort and its research agenda and organisational setup was described in the previous episode. The programme was prolonged and continued until 1994. In 1993, two evaluations of this programme were published (KNAW 1993; RMNO 1993). The first, conducted by the Dutch Royal Academy of Science and Arts, addressed the scientific achievements of the programme. The evaluation was very positive. The second evaluation was conducted by the RMNO, the advisory council that had provided the basis for the programme, as explained in the first episode. The RMNO was similarly positive about the scientific achievements, but was critical about the achievements of the programme for the further development of soil policy, and for the progress of soil cleanup. The advisory council urged to continue the exchange of research findings by 'topping-up projects' (Rogaar 1993), or through workshops and meetings. In addition, the council advised to develop expertise and research into policy and administrative studies. Apparently, scientists were somewhat uncomfortable with the criticism from the advisory council and they pointed out their achievements as well as the proposed improvements:

> We managed, (…) to restructure the initially fragmented and uncoordinated research on soil quality and pollution by a joint effort of organisations and institutions. It turned into a network with intense contacts and the willingness to share tasks. Research as initiated by SPBO increased insight into the functioning of the soil ecosystem and was internationally respected.
> (Bolt 1993)

> One of the most difficult parts of SPBO was the transfer of findings to policy. (…) Crucial is that the results of SPBO will be taken up in practice: the next phase (1994-1997) is therefore geared towards implementation. The end users must be actively involved.
> (Eijsackers et al. 1993)

The critical message submitted by the RMNO supported the plans that already existed for the research programmes ahead: these programmes focused more on practical techniques for cleanup (NOBIS: 1994-1998), or, as desk studies, on translating findings to practice (PGBO: 1996-1999). SKB, the later research programme (1998-2003), was structured as a partnership programme with public and private parties co-funding research and implementation. However, as we will also see in the third episode, the suggestion to develop expertise on policy studies was not included. My interpretation is that in these research programmes, the course was set by scientists focusing on the scientific analysis of the problems with a blind spot for policy and decision-making procedures as subjects that would deserve research efforts. We will also see in the third episode that suggestions to include a social science research programme within SKB do not get any further than the initial documents setting a proposed outline of an ambitious programme.

Under the flag of SPBO an annual symposium was organised and a journal was published. The annual symposium was organised for the first time in 1988. Initially, it was meant to be a platform for scientists participating in SPBO, to meet and exchange knowledge. Since the start of PGBO in 1995, efforts were made to involve policymakers and private parties, such as consultancies and other companies. The attempts were successful, and the Annual Symposium became a prime meeting place for knowledge exchange and networking. The participants' backgrounds and affiliations are varied. A survey held at the 10th meeting in 1998 revealed the importance of the meeting with regard to knowledge exchange and networking by both scientists and policymakers (Souren et al. 2000). The 'Bodem' journal was first published in 1991, following an initiative of the programme secretary of the SPBO. It is a professional journal that finds its contributors and readers among the several actors involved in soil policy. It covers soil policy in a broad sense. Soil protection, soil treatment, policy developments, scientific findings and experience from cleanup projects. An agenda section is included, as well as a section in which new reports and developments are signalled. At the title page of each article, a photograph is provided of the author, as well as his or her affiliation and some key information about his or her expertise. Such information also helps the networking function of the journal. Contributions are reviewed by the members of the editorial board recruited from active participants that know about the developments and who are embedded in a large network of policymakers and the different government levels. The journal is still being published (2006).

4.2.5 Setting integrated environmental quality objectives

The policy document entitled: Environmental quality objectives soil, water (MILBOWA) (Min.VROM 1991) became the first product of a large policy programme Setting Integrated Environmental Quality Objectives (INS). The research was conducted at the National Institute for Public Health and the Environment (RIVM). In a number of subprojects, environmental quality objectives were derived for substances in soil and water. The research was supervised by a scientific supervisory committee. The results of the research were reported to the interdepartmental working group Setting Integrated Quality Objectives (IWINS). Advice on the reports was provided by the TCSP and the Health Council.

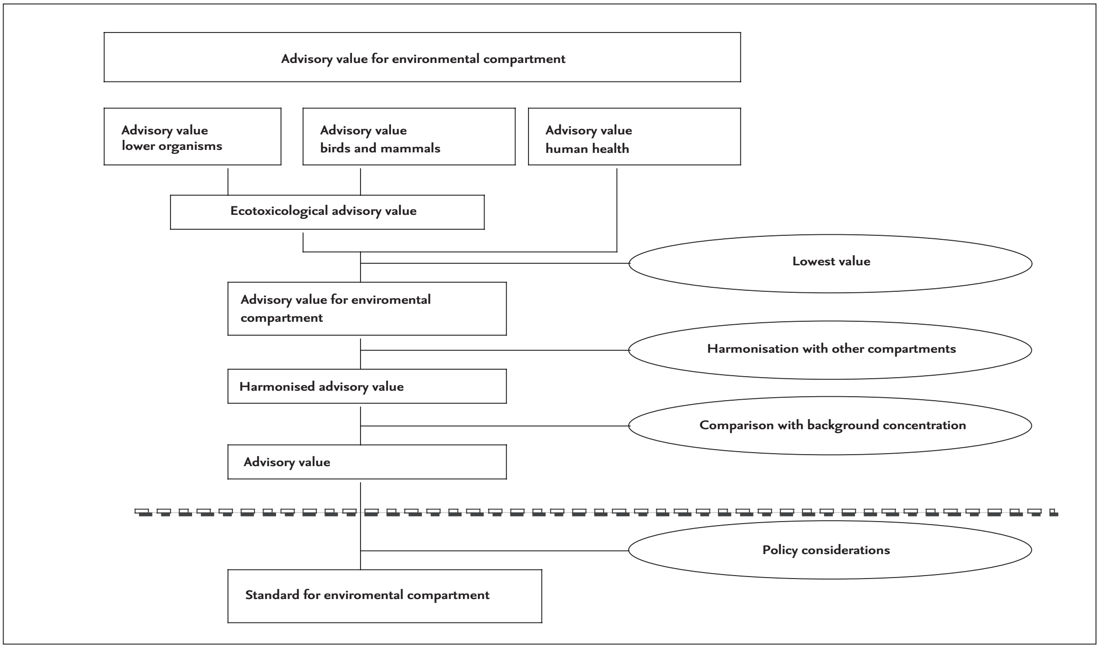


Figure 4.2.2 Procedure to derive integrated environmental quality objectives. Above the dashed line is the scientific underpinning, below the dashed line the policy process to set the standards (Gezondheidsraad 1995).

This policy project was meant to further the harmonisation of environmental policy. It provided the window of opportunity to proceed with the further harmonisation of environmental quality standards for air, water, soil and radiation. Environmental policy used to distinguish between the different environmental compartments. Water, soil, air and radiation each had their own specific background and history, making it difficult to integrate the respective policies. Integrated standard setting refers to the integrated approach of all compartments. Tuning standards to the various environmental components triggered the development of a specific category of models: multimedia models. It should be observed that the procedure to arrive at standards in Figure 4.2.2 (repeated from Figure 1.3b) illustrates the relation between scientific knowledge and policy for standard setting. The proposed procedure reflects a realistic view on policy development and is informative about the formal representation of the relation between science and policy in setting standards.

4.2.6 The institutional context in episode 2, an integration

In this second episode, criticism with regard to the guiding principle of multifunctionality grows. The criticism is not focused on this concept as a cognitive concept, but concentrates on the practical and financial problems of implementing it. The initial vagueness of the concept that explained its successful role in establishing a joint science and policy community in the first episode (see my interpretation about this in episode 1) turns into its weakness in this second episode. It has not been sufficiently translated into operational concepts and measures, causing immediate implementation problems. Parallel to this criticism, two new concepts develop: the risk approach as a cognitive concept, and active soil management as a management concept in which the implementation of soil policy is the central concern. The latter concept has not yet been explored in full, but will return prominently in the next episode. Not surprisingly, active soil management is brought to the fore by the government actors most involved in the implementation of soil policy: the Association of Netherlands Municipalities (VNG). It also criticises the generic nature of the principle of multifunctionality. The VNG pleads for a location-specific and land-use based approach for the development of soil quality standards (a functional approach). The second episode is summarised in Table 4.2.1.

Table 4.2.1 The three dimensions of the institutional context in the second episode. For each dimension critical events, achievements and developments explained in the text above are given in the table.

Regulative	• Integration of Interim Soil Pollution Act and Soil Protection Act (1994)
Cognitive	• Risk approach
	• Multifunctionality
Normative	• Active soil management
	• Increase in number of actors involved in policy development (notably the VNG, the IPO)
	• Integration of environmental policy fields
	• Criticism with regard to abstract and insufficiently operational principles guiding soil policy
	• Soil research programme (Netherlands Integrated Soil Research Programme SPBO)

4.3 New steering concepts: 1995-2000

Section 4.2 described the developments since the acceptation of the Soil Protection Act in 1987 and the publication of the reference values in 1988. In 1994, the Interim Act Soil Pollution was integrated into the Soil Protection Act. Curative and preventive soil policy was integrated into one regulatory framework and target and intervention values were developed, which were initially indicated by A values, later by the reference values and the negligible risk level (target values). The inclusion of the Interim Soil Pollution Act decreased the authority of the regional governments to decide about targets for treatment of specific local sites and in many cases this resulted in stagnation of cleanup. The VNG's report, discussed in the previous episode, was a reaction to this. In the third episode the VNG further successfully uttered its concern about the standards setting and policy process. Processes and activities that required an assessment of soil quality stagnated because of the complex procedures and strict standards. In addition, urgent cases of soil pollution that posed risks either to human or ecosystem health were not cleaned as planned, increasing the environmental risks. The stagnation made soil policy vulnerable to criticism from other outside the policy field as well.

In the episode described in this section, the reflections and proposals for renewal as discussed in the previous episode were implemented. These renewals concerned the cognitive and normative dimensions and took place within BEVER, a Dutch acronym referring to BEleidsVERnieuwing Bodemsanering (Renewal of soil pollution policy). Flanking BEVER, several reports appeared that are discussed here. Besides these developments in policy, research programmes are discussed. Together these developments in science and policy provide the institutional context for development of soil remediation objectives (SROs).

4.3.1 Policy renewal; BEVER

In 1995, the renewal of soil policy was started. A crucial report that paved the way for the policy renewal was an analysis by the Association of Netherlands Municipalities (VNG) published in 1995. This document (Moet and Peters 1995) took a radical different perspective on the issue of soil pollution. The authors analysed the problem of soil pollution from the perspective of municipalities. Municipalities integrate societal, spatial, planning and economic perspectives in decision-making about housing, for instance. In the VNG's analysis, soil pollution affects the possibilities and constraints for housing, building and construction works. Municipalities have a legal responsibility to assess soil quality at building and construction locations. The legal framework (Housing Act and the Spatial Planning Act) for building and construction prescribed that risk assessment would have to take into consideration human health. The existing assessment scheme for soil quality was developed in soil protection policy and included soil quality standards based on effects on human health, ecosystem health, and risks of diffusion of pollution. These standards were tighter than required for a risk assessment for building and construction. The VNG report made it very clear that the environmental perspective that had dominated the development of soil policy, and the development of standards for soil policy in particular, was deemed inadequate from the perspective of local government. For municipalities, spatial planning and economic perspectives to soil quality were equally important. Soil quality standards were originally not developed for that purpose and came under attack by the widening up of the policy fields in which they were implemented. The report continued with the policy consequences of a study conducted by the National Institute for Public Health and the Environment (RIVM) (Bockting et al. 1994a, 1994b, 1994c). That study, commissioned by the Association of Netherlands Municipalities (VNG) and accorded by the Ministry of Public Housing, Spatial Planning and the Environment (VROM), was meant to develop an assessment scheme for soil quality to be used by municipalities while applying the Housing Act and the Spatial Planning Act. The resulting assessment differentiated between four land-use types, based on exposure to soil pollution, and proposed standards for each land-use type.

- *Housing with garden with vegetable garden (50% of consumed potatoes and 100% of consumed vegetables assumedly come from this garden)*
- *Housing with garden (10% consumption from this garden)*
- *Recreation and public green space*
- *Housing without garden, infrastructure, construction works*

The report by the VNG made explicit the role of soil quality standards from the perspective of local government. With this document, the VNG set the scene for a drastic renewal of soil policy. Policy renewal should be geared towards the practice at the regional and local government level. Multifunctionality had become the guiding principle not only for soil policy, but also for the development of the standards. With this criticism by the VNG on the inadequacy of the standards, the principle of multifunctionality was attacked, and with that, the basis for existent soil policy as developed since 1971. The renewal of soil policy now was no longer a paper proposal, but was getting implemented as BEVER started in 1995. Section 4.3.2 describes the development of BEVER and the interdepartmental policy study by the Soil Remediation Working Party.

4.3.2 New relations between involved parties and new concepts

In June 1995, a workshop was organised in which representatives of the traditional soil policy sectors of the Ministry of Public Housing, Spatial Planning and the Environment, the Association of the Provinces of the Netherlands (IPO), and the Association of Netherlands Municipalities (VNG) participated, as well as representatives from Spatial Planning and Economic Affairs, two policy fields in which soil pollution was getting increasingly important. As a follow up to the workshop a 'Target Perspective' was written formulating the basic targets, assumptions and perspectives for soil policy (Alons & Partners 1996) The assumption in the Target Perspective was that agreement and consensus about these basics would guarantee the commitment of all involved parties. In the Target Perspective, six aspects were identified as central to the policy renewal process:

1 *From sectoral to integral*
2 *From multifunctionality to function-based*
3 *From project to process*
4 *From central to de-central*
5 *From government to market dynamics*
6 *From setting standards (values) to sharing standards (values)*

The first aspect; 'from sectoral to integral' referred on the one hand to the further harmonisation of environmental quality standards for the different environmental compartments that was started since the introduction of the risk approach in 1989. On the other hand, it referred to the integration of the policy fields of sectoral environmental policy, housing, agriculture and spatial planning. The second aspect concerned the cognitive dimension underlying soil policy. It referred to earlier suggestions to reconsider the basic principle of multifunctionality. These suggestions were already made in the previous episode, for instance in the report by the Welschen Working Group (1993). As mentioned in the previous episode, this Working Group had coined the concept of 'active soil management' as an additional or alternative concept in soil policy. The third aspect related to a tendency in policy to shift focus from a project approach to a process approach. For instance, process-related standards and protocols were introduced in soil policy. The fourth aspect referred to the manifestation of the IPO and the VNG as mentioned above. Besides their report in 1995, the VNG had already brought forward an alternative approach to the intervention values in 1992 (see Episode 2 (VNG 1992)). The fifth aspect had also been mentioned before by the Welschen Working Group (Werkgroep Bodemsanering 1993) as a possibility to involve more private parties in the financing of soil treatment operations, thus reducing the burden for government. The sixth aspect is related to the fourth in the sense that it is a plea for a more open and participatory process involving more actors.

After the publication of the Target Perspective, a Working Group was composed to implement it. For a further understanding of this policy renewal it is important to recall the aims of the policy renewal. The renewal of soil policy aimed to take away causes of stagnation, to reduce the costs of treatment and to increase the progress of cleanup. The Target Perspective marked a shift at the cognitive dimension (a function-based approach was introduced as an alternative or complementary to multifunctionality and the risk approach). It also marked a shift at the normative dimension as it explicitly addressed the relation between the different government layers. The Working Group produced a working plan resulting in four projects (BEVER 1, 2, 3, and 4, (Min.VROM et al. 1996)Of these, BEVER 1 specifically addressed the conceptual orientation of the new policy and its instruments, including the development of new standards. BEVER 2, 3, and 4 concerned administrative, financial, and legal procedures and quality control mechanisms. As the focus is on the development of soil quality standards, only the BEVER 1 project is discussed here in more detail.

The project results of BEVER 1 were published in a report by Witteveen+Bos in 1997 (Witteveen+Bos 1997). The report contained a reflection on assumptions in soil policy and standards. One of the most revealing illustrations is (slightly modified for clarification) included here in Figure 4.3.1, which shows that the problem of polluted soil is shared by three policy fields: Spatial Planning, Environment and Economy.

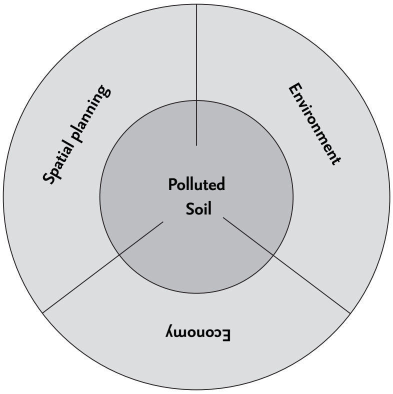


Figure 4.3.1 Polluted soil visualised as shared by three policy fields: Environmental Policy, Spatial planning and Economy (Witteveen+Bos 1997).

Figure 4.3.1 illustrates what the VNG has written before in the reports discussed in the second episode (VNG 1992) and what (Moet and Peters 1995) discussed above. The first part of the BEVER 1 project document argued that presently the development of soil policy was 'located' in the 'environment' wedge of the pie, while in implementation at local and regional levels, soil pollution had spatial planning and economic consequences. The visual representation of the position of soil policy at an overlap between three policy fields opened up new vistas for soil policy that were further explored in the document. The second part of the document hence focused on the development of such future and alternative course for soil policy, where it would be recognised that soil was no longer only an environmental compartment, but also an economic and social resource. This recognition, it was argued in the report, required the integration of environmental policy and spatial planning approaches towards soil. The report compared the six aspects from the Target Perspective to existent approaches in Environmental policy and Spatial Planning and identified two approaches; the existent, top-down target-driven approach and a consensual, process-oriented and participatory approach. The renewal of soil policy in the BEVER project aimed at a move into the latter direction. The document explicitly connected the top-down target-driven approach to environmental policy whereas the consensual, process-oriented approach was connected to spatial planning policy.

> Environmental policy can be characterised as centralistic and normative in contrast to spatial planning policy, which is more oriented towards local and consensual.
> (Witteveen+Bos 1997))

> To date, soil pollution policy is characterised by its hierarchical top-down approach with a clear normative perspective.
> (Witteveen+Bos 1997)

These quotes illustrate that the policy renewal concerned a renewal of the relations between involved parties, i.e., the normative dimension. In the BEVER 1 report, the second aspect of the Target Perspective (From multifunctional to function-based) was not treated in detail. Remarkably, the BEVER 1 project, meant to discuss the conceptual direction of soil policy, produced an uncritical analysis that focused on the normative dimension and was geared towards a reconfiguration of the involved policy fields and policy levels. A reconsideration and further specification of the principle of multifunctionality would have been possible, but it was rejected and replaced by a new approach, one that was more specific about the relations between involved parties. The cognitive and normative dimensions of soil policy were not analytically distinguished as such in the report. Rather, they were used as similar and conceptually equal.

By the time the BEVER 1 project was conducted, a policy study by the Interministerial Working Group Soil Remediation (Interdepartementale Werkgroep Bodemsanering 1997; Staatscourant 1996) was reaching its gloomy conclusions. The high (€50 million estimated in 1997) and ever-increasing remediation costs (a hundred million euros annually, estimated in 1997) called for action. With an annual expenditure of €0,5 million, the cleanup operation would take a hundred years.

> There will be no option but to leave following generations with a legacy of serious soil pollution.
> (Interdepartementale Werkgroep Bodemsanering 1997 p. 3)

This interministerial study proposed to reduce the size of the problem by reconsidering the cleanup objectives; i.e., abandon multifunctionality as the objective of treatment. Instead, the new treatment objective would be function-oriented and cost effective; that is, the function (land use) would determine the treatment objective. Two policy alternatives were developed for cost effectiveness. The first alternative was called the ‘environmental returns alternative’ and it implied that:

> The environmental returns from the cleanup measures are of central importance. This means that the appraisal must result in establishing the most desirable and cost-effective cleanup result from an environmental point of view.

The second alternative was called the 'returns on user alternative' and it implied that:

> This alternative means in practice that, for example, the owner of a polluted industrial site removes as much pollution as to make the environmental risks associated with its current use permissible again unless he deems it in his interest to remove more pollution, for example, to increase the selling value of the site. If the soil is to be used later for a more sensitive function, the site will have to be cleaned up again.
> (Interdepartementale Werkgroep Bodemsanering 1997)

A calculation was made of the reduction in costs of the two alternatives compared to present practice. This revealed that the first alternative (the environmental returns alternative) would reduce costs by 35%. The second alternative (returns on user alternative) would reduce costs by 50%. The policy study left the two alternatives open for consideration. In the concluding section, the working group stressed the regional nature of soil pollution issues and the need to de-centralise soil policy. The report concluded that:

> Active soil management… could result in the advocated integration of soil remediation into social processes.
> (Interdepartementale Werkgroep Bodemsanering 1997)

In other words, soil was also reframed in this document. Soil was framed in the report as a resource for social and economic growth. Soil pollution was reframed as more of a social, economic and spatial planning problem than an environmental compartment, as documents in earlier episodes showed. This study was in line with the BEVER 1 report in the sense that it suggested a shift from an environmental perspective towards a Spatial Planning perspective. Where the evaluation by the Welschen Working Group, discussed in the previous episode, (Werkgroep Bodemsanering 1993) had 'protected' the guiding principle of multifunctionality, the present report 'Good ground for growth: new incentives for soil remediation' proposed to abandon it and replace it with active soil management as a guiding principle, including a land use based approach to soil quality standards. The working group also included an analysis on knowledge infrastructure. It underlined the conclusions of the report by the Committee on Coordination and Co-financing of Soil Research CCFBO (Commissie coördinatie en co-financiering geïntegreerd bodemonderzoek 1996), to set up a platform (SKB, Stichting Kennistransfer

Bodem) where supply and demand for scientific knowledge could come together. This CCFBO report is discussed in Section 4.3.6.

Compared to the previous episodes a shift took place with respect to the framing of soil and soil pollution. In the first episode, the Ministry of Public Health and the Environment had successfully and with great effort framed soil as an environmental compartment. Remember the efforts to develop an overarching Soil Protection Act under the responsibility of the Ministry of Public Health and the Environment as described in the beginning of this chapter. In this third episode, soil was reframed, out of environmental policy and into the realms of economic and spatial planning policy. It might have to do with the merger between the Ministry of Public Health and the Environment and the Ministry of Public Housing and Spatial Planning (in 1982) causing a reframing of the issues within the new Ministry, but from the documents published in this episode it seems that implementation problems experienced at local and regional governments were decisive. The shift in the guiding principle for soil policy (from multifunctionality to land use based) was motivated by referring to the practice related to the concept of active soil management, not to the content of these concepts. This further supports the interpretation that the renewal at the cognitive dimension, as proposed in the above interdepartmental policy study, was meant to facilitate the renewal of the normative dimension that was elaborated on in detail in the BEVER 1 report. The origin of the concept of 'active soil management' further supports this analysis: dissent with the perceived hegemony of the central government compared to local and regional government. Active soil management promised to facilitate the revision of the role of central government and the relation between the national, provincial and local government. Section 4.3.3 examines the concept more closely.

4.3.3 Active soil management

This concept was coined in the report of the Welschen Working Group, mentioned in the episode 2 in this chapter (Werkgroep Bodemsanering 1993), where, active soil management was defined as:

> The total of activities in an area geared towards adequate and efficient conduct with regard to the consequences of structural soil pollution.
> (Werkgroep Bodemsanering 1993)

The concept grants a central role to activities by different actors, and makes soil quality subordinate; a certain soil quality is the eventual outcome of activities that do not exclusively aim at the improvement of soil quality. This focus on activities, rather than on a stated output of these activities was unfamiliar to many of the involved parties. To inspire parties to implement this new approach in treatment operations, two books were published containing examples from municipalities, companies and other stakeholders to take away the stagnating impact of soil pollution on building and construction works by searching for creative solutions to clean, remove or otherwise mitigate soil pollution. In the First Working Book on active soil management (IPO et al. 1996), the concept of active soil management was connected to chain management. Active soil management referred to the chain: prevention-management-treatment-aftercare, with the aim to realise sustainable use of soil in a socially acceptable manner. In the Second Working Book on active soil management (Moet et al. 1998), focus was on active soil management as a process. In the book, quality control of the process and knowledge transfer were identified as important aspects for the success of active soil management. Active soil management was tried by scientists as a guiding concept for research programmes.

A group of scientists and practitioners also explored active soil management as a guiding concept for future research programming (Ouboter et al. 1996). They formulated it as follows:

> All activities required to handle polluted sites with several and diverse bottlenecks (technical, spatial, organisational and financial).
> (Ouboter et al. 1996)

This attempt by scientists could be interpreted as an attempt to keep connected to the changes in soil policy by exploring the new concept, in the same way as the concept of multifunctionality. The latter concept had very successfully served as a boundary concept in the first episode. After an initial attempt to launch 'active soil management' as a new boundary concept for science and policy, the concept was used mainly in policy and did not return as a guiding principle in research programmes.

4.3.4 Cabinet's position concerning the renewal of soil policy

The ongoing BEVER process together with the above-discussed interdepartmental policy study provided input for the position of the Cabinet concerning the renewal of soil policy. In a letter to the Lower House of Parliament in June 1997, a change of course was presented which entailed making remediation cheaper by gearing cleanup measures to the desired land use of a site (function-oriented remediation). The new course applied to soil contamination which had taken place before 1987. Soil contamination occurring after that date was subject to soil policy as formulated in the Soil Protection Act that became operational in 1987. The new course meant that the 'restore multifunctionality, unless… 'approach was abandoned, at least with regard to soil contamination dating from before 1987. The indication of severity and urgency of a remediation case were not affected by the new policy. 'Only' the treatment goal or objective was affected. The Cabinet chose not to select one of the two alternatives (environmental returns alternative or returns to user alternative) that were developed by the working group in the interdepartmental policy study. Rather, the Cabinet proposed to develop guidelines for this appraisal process (of effectiveness) in the context of BEVER and decentralised this appraisal process to the local and regional policy level. Part of the development of this appraisal process was the development of soil remediation objectives; soil quality standards.

The policy renewal was about pollution that originated from before 1987 (the year the Soil Protection Act became operational). After 1987, the principle of multifunctionality and related concepts determined the targets of remediation and mobile and immobile pollution were differentiated for the first time. A second differentiation was made between subsoil and topsoil. A third differentiation was made between four land-use types, as shown in Table 4.3.1 in the following section. A fourth differentiation was made between standard treatment and a customised approach. A fifth differentiation was made between a customised approach per case, and a customised approach per area. The standard approach consisted of the application of a surface layer. This standard approach could only be applied to immobile pollution. The development of these soil remediation objectives is the subject of Chapter 7. The development of guidelines for the appraisal process became the task of 'Team A' within BEVER. The work of this Team A is the subject of Section 4.3.5.

4.3.5 Establishing remediation objectives within BEVER

The results of the work of Core team A were published in 1999 under the title: From funnel to sieve. The title of the document refers to the difference between a funnel and a sieve: the flow of treatment projects can get blocked in case a large project blocks the funnel. Once a large project blocks the funnel, not even small and simple projects can pass through. Through a sieve, the relative simple and small treatment projects can pass, leaving the large and complex projects behind for a customised approach. The metaphors of funnel and sieve are used to illustrate the attempt to reduce the stagnation that can result from the blocking of the funnel by replacing the funnel by a sieve. The report 'From Funnel to Sieve' was meant to set the boundaries of the playground within which location-specific treatment could be formulated. The development of new standards, in line with the six aspects of the Target Perspective (see Section 4.3.2) was one of the main tasks of project A. The 'old' soil quality criteria had to be reformulated to be made consistent with and to facilitate the 'new' soil policy. First of all, this required the development of a typology of land use. In Chapter 7 this development is explained in detail. Secondly, standards had to be formulated in each of these land-use types that were related to the risks to human and ecosystem health. This is also explained in Chapter 7. The list of soil remediation objectives as published in 'From Funnel to Sieve' is reproduced here.

Table 4.3.1 Land-use types and soil remediation objectives in mg per kg dry soil. No SROs are derived for land-use type 3, as it is assumed that there is no exposure (and therefore no actual risk to human health). This land-use type has no ecological requirements, as this land-use type does not aim to support the ecological function. For land-use type 4 a customised approach is envisaged.

	Land-use type 1: Housing and intensively used (public) green space	**Land-use type 2: Extensively used (public) green space**	**Lland-use type 3: Construction and pavement**	**Land-use type 4: Agriculture and nature**
Cr	300	380	Not applicable	Customised approach
Ni	50	210	Not applicable	Customised approach
Cu	80	190	Not applicable	Customised approach
Zn	350	720	Not applicable	Customised approach
Cd	1	12	Not applicable	Customised approach
Hg	2	10	Not applicable	Customised approach
Pb	85	290	Not applicable	Customised approach
As	40	40	Not applicable	Customised approach

The customised approach to be applied in land-use type 4 was not further explained in the report. It was suggested to develop a customised approach per case or per area but the issue was not resolved in the report. The differentiations carried with them the risk of inequality in terms of soil quality. Location-specific approaches could result in different soil quality at different sites. Here the legal responsibility of national government embodied by the Ministry of Public Housing, Spatial Planning and the Environment to safeguard the generic soil quality urged to demarcate the degrees of freedom for location-specific treatments. This required further work and specification. Another issue that had been identified in the Cabinet's position that had not been resolved was the approach for subsoil, i.e., mobile pollution. The concept of 'stable end situation' was introduced, to denote that treatment would have to be geared towards a stabilisation of the plume of mobile pollution, spreading from the source, but the policy regarding mobile pollution was not yet fully fleshed out.

The TCSP commented on the report and stressed to develop a policy for subsoil. It addressed specifically the monitoring and 'Aftercare of mobile pollution'. In addition, the committee anticipated a 'new' attitude to soil quality, in which environmental quality became subordinate to economic value. The committee urged to reflect on this while further developing the practice of active soil management. The use of the concept of active soil management broadened the connotation of soil. It began to include soil as a resource for social and economic development. Under the heading of active soil management, slightly contaminated soil could be transported to other sites to be used as a surface layer (see above). However, for the transport and reuse of soil, the Building Materials Decree applies. Under the Building Materials Decree however, slightly contaminated soil (with concentrations exceeding the intervention values) was *not* allowed to be reused. The intervention values were developed in soil policy as instruments to assess the quality of soil as an environmental resource and differentiate between soil that had to be treated and soil that was fit for multifunctional use. In the new soil policy this soil quality (exceeding the intervention values) could be applied as a surface layer in soil-use type III, Built-up and pavement. This is not consistent with the Building Materials Decree. Within soil policy no restrictions were identified about the application of soil in building or construction. The intervention values were used in the Building Materials Decree to differentiate between the options for use as building material. Now that active soil management had become a practice within soil policy, the need emerged to relate the Building Materials Decree to regulations in soil policy. An immediate characteristic of the appraisal process was the proliferation of differentiation and categorisation of soil quality and treatment. Compared to the existent remediation goal (target values, i.e., multifunctionality) the remediation goal appraisal process had become far more complex and differentiated. This differentiation was one of the results of the decentralisation of soil remediation and location-specific treatment of sites.

The above sections have given an overview of the developments in soil policy where new approaches were proposed. A similar development of new approaches could be identified with respect to the development of scientific knowledge and the organisation of research programmes.

4.3.6 Steering research programming

Besides the renewal of policy as described in Section 4.3.5 above, the steering and programming of research programmes was reconsidered. This reconsideration matched the tendency in science policy to focus more on market-oriented, programmatic research programming. The Committee on Coordination and Co-financing of Soil Research (the Van der Vlist Committee) was commissioned by the the Ministry of Economic Affairs, the Ministry of Education, Culture and Science, the Ministry of Public Housing, Spatial Planning and the Environment, the Ministry of Agriculture, Nature and Fisheries, and the Ministry of Transport, Public Works and

Water Management to advise about the development of knowledge adequate to be applied in soil remediation. Task of the committee was (a) to develop proposals for a more demand-driven soil research that would increase the available knowledge and technology for treatment of polluted sites. Also, the committee was asked to (b) investigate possibilities to enhance the co-funding of research by private parties, including those parties that could be held responsible for the pollution. The task of the committee was based on the need to increase the performance of the treatment of polluted soil and reduce the costs for central government. In its advice, 'Soil Science Applied' (Commissie coördinatie en co-financiering geïntegreerd bodemonderzoek 1996), the committee identified transfer of knowledge from supply to demand as the bottleneck for the development of applicable knowledge.

> An essential part of the R&D structure is the transfer of knowledge. Transfer of knowledge means: linking the demand for knowledge to the supply of knowledge. Coordination and co-funding of soil research mainly aim at the advancement of knowledge transfer.
> (Commissie coördinatie en co-financiering geïntegreerd bodemonderzoek 1996)

Supply side
- Knowledge supply is fragmented
- Knowledge is insufficiently multidisciplinary
- Knowledge suppliers focus on knowledge production and not on knowledge application

Demand side
- Parties are unaware of and unfamiliar with R&D concepts and strategies
- Parties lack an overview of the available knowledge and are not competent enough to articulate research needs
- There are insufficient financial resources

(Commissie coördinatie en co-financiering geïntegreerd bodemonderzoek 1996)

The committee underlined the importance and role of intermediary organisations for knowledge transfer, and continued that such intermediary organisations were already active. Apparently, additional mechanisms were required if knowledge transfer were to be improved. In its report, the committee advised to increase cooperation and commitment between knowledge supply, demand and intermediaries. The committee proceeded to conclude that financial commitment of involved parties and assessments of achieved results of cooperation are essential success factors for knowledge transfer. Later in the report the committee proposed to establish SKB (Knowledge Transfer Soil) based on experiences with previous research programmes NOBIS and, to a lesser extent, PGBO. This report revealed the then current perception of the relation between science (as knowledge supplier) and policy (as the demand side). The committee sketched current practice as containing two separate domains; the domain of policy and the domain of science.

In the first part of the literature review in Chapter 3, it was made clear that representations of science and policy as two distinct domains can be functional as an explanation of an ideal type situation, but not as representations of actual practice. The proposal of the committee must therefore be questioned. After pointing out the limited success of intermediaries, the committee proposed SKB as a facilitator of the cooperation between knowledge supply and knowledge demand. SKB would have to bring together parties in temporary consortia and assist these consortia. This proposal was very much in line with the analysis by Gibbons and co-workers (1994) in their influential book discussed in the third section of the literature review in Chapter 3. In their book, the authors identified a shift towards the setup of temporary consortia within which contextual knowledge was developed to solve the problems identified by the members in the consortium (Mode 2). The relevant research programmes in the third episode were PGBO, NOBIS and SKB. These are explained below.

Programme Integrated Soil Research; PGBO

This programme was launched in 1995 as a successor of the much larger SPBO and ended in 1999. The total resources available for PGBO were about k €210, which is approximately 10% of the size of SPBO, the preceding research programme. The funding was provided by the same parties as those funding SPBO: the Ministry of Education, Culture and Science, the Ministry of Public Housing, Spatial Planning and the Environment, the Ministry of Agriculture, Nature and Fisheries, and the Ministry of Transport, Public Works and Water Management. There was no involvement from the private sector. PGBO relied on the programme infrastructure as it was developed for SPBO. However, the organisation structure for PGBO was simple compared to that of SPBO (compare Figure 4.3.3 to 4.1.1). PGBO was a different programme in several respects. It was designed in response to the evaluations of SPBO (RMNO 1993). Insufficient translation of relevant knowledge to application was the main criticism. It was suggested in the evaluation that a programme was needed to translate all developed fundamental, or basic, knowledge from SPBO to application. PGBO would therefore be much more a desk research programme, than a programme in which experimental research was conducted. In addition to the translation of knowledge, PGBO would have to consolidate and increase the networks between scientists and deepen the relation between science and policy. As an example, the National Soil Research Symposium as it was started by SPBO was reorganised and renamed as National Symposium 'Bodem Breed' (Soil Wide), in which soil policy as well as soil science were represented. Also discussion platforms were established by PGBO.

The origin of PGBO illustrates the then prevailing perception of the relation between fundamental and applied, usable knowledge. Usable knowledge was seen as the result of a translation process starting with fundamental knowledge as the

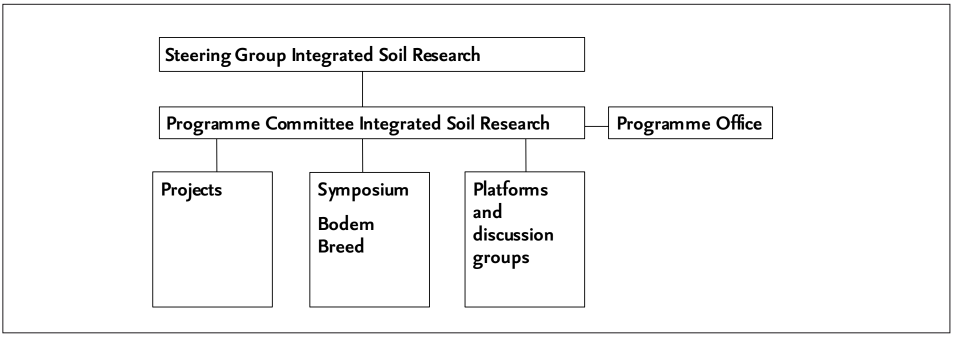


Figure 4.3.3 Organisational structure of PGBO (after (Rogaar 1997)

input and usable knowledge as the output. The translation process was perceived to be a matter of bringing people together and writing reports in which basic knowledge was translated into knowledge ready for application. It was believed that bringing people together more often, would enhance this translation. Compared to previous programmes, focus was not so much on the development of new technical knowledge, but on the translation of existing knowledge and the development of concepts and strategies. In retrospect, research developed under the flag of PGBO became geared towards knowledge to manage polluted soil sites and solve complex problems. In doing so, soil pollution was increasingly framed as a social problem, instead of an exclusively scientific problem. Projects funded by PGBO were often conducted by other than academic scientists, who dominated the SPBO projects. Several studies within PGBO pointed to attention for process management and knowledge utilisation and the need to involve problem perception and communication strategies in solving these complex problems (Canter Cremers et al. 1999).

In addition to the development of PGBO, a related trend was to produce knowledge for in situ extensive treatment. This knowledge was developed in NOBIS. The development of NOBIS was already announced in 1993 by the Welschen Working Group that drew attention to in situ techniques as these were promising and relatively cheap treatments (Werkgroep Bodemsanering 1993).

Dutch Research Programme Biotechnology In-situ Sanitation (NOBIS)

This research programme was launched in 1994 and ended in 1998. The total budget was about €17 million; two third was funded by the Ministry of Economic Affairs, the Ministry of Education, Culture and Science, the Ministry of Public Housing, Spatial Planning and the Environment, the Ministry of Agriculture, Nature and Fisheries, and the Ministry of Transport, Public Works and Water Management. One third of the total budget was supplied by private parties. The aim of NOBIS was:

> …to develop, evaluate and demonstrate innovative strategies, methods and techniques from biotechnology for in situ treatment and management of contaminated soil.
> (Rogaar 1997)

NOBIS was the first programme in which the approach of public and private funding was applied. This approach reflected the shift in perception of the development of usable knowledge. The research programmes until then (SPBO and PGBO) perceived the development of usable knowledge as a matter of translating basic, academic, research through desk studies and by organising meetings where research findings could be communicated. There was only limited involvement, or none at all, from private parties, and from actors with other than academic/scientific perspectives on the problem of soil pollution. This changed drastically with the establishment of NOBIS and SKB. These programmes included research as a means to solve problems at polluted sites. There was another change in the development of soil policy in the research programmes: originally, at the onset of soil policy, soil was framed as a public, government-managed environmental resource (remember the efforts by the then Ministry of Public Health and the Environment to establish a position for an overarching Soil Protection Act, amidst claims from the policy fields of Economic Affairs and Agriculture, see episode 1 for an overview). This concept was replaced: soil (also) became a private resource that could be assessed in monetary value. In line with this new concept, soil became a societal and economic resource, next to an ecological or environmental resource. Both research programmes illustrate that research programming became more practical, more oriented towards solving the complex problems at polluted sites, than analysing them or providing data to calculate standards.

NOBIS focused on in situ treatment techniques and approaches. NOBIS was not only relevant with regard to the technical knowledge it developed, but perhaps even more so in its innovative organisation of the programme. Co-funding organisations were represented in the supervisory board. In NOBIS' board, all involved stakeholders were represented: (local, regional and national) government, public service corporations, technological institutes and universities, contractors, consultancies and consulting engineers. The board received advice about the scientific content of the programme from the scientific advisory board. The Knowledge Integration Team (KIT) brought in innovative ideas and it had to enhance the consistency and creativity of the projects. Members of the KIT represented the NOBIS projects (varying from the Ministry of Public Housing, Spatial Planning and the Environment, to consultancies and academic researchers).

Foundation Knowledge Development and Transfer on Soil; SKB

SKB reconsidered the classical distinction between science (as the producer of

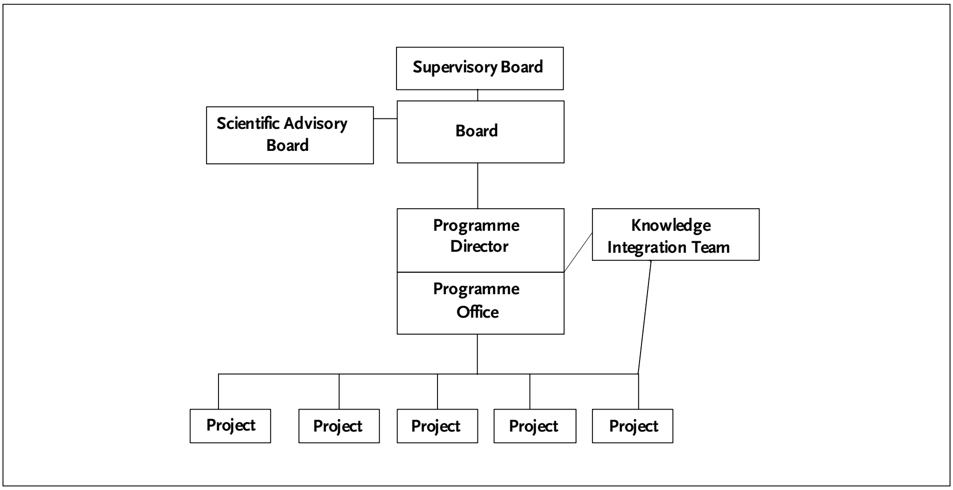


Figure 4.3.4 NOBIS' organisational structure (Rogaar 1997)

knowledge) and policy (as the demand side). SKB matched owners of a problem with parties that could contribute to a solution. Scientific knowledge contributed to the solution of the problem but was not granted the status of 'exclusive provider of a solution' it used to have. Scientists became participants in SKB just like local governments, local interest parties and private parties. This philosophy reflected the then prevailing notion of 'joint and shared' processes, that we have seen so clearly illustrated by BEVER. As a research programme, SKB started from a less positivistic approach compared to the dominant approaches in the first and second episode. In its business plan, SKB, for instance, made it explicit that it was meant to support the implementation of policy as developed by the Ministry of Public Housing, Spatial Planning and the Environment. Still, the vocabulary in the business plan was dominated by 'supply side and demand side'

> When setting up an integrated approach to knowledge transfer it must be borne in mind that the actual approach to knowledge transfer is not fit for future developments. Actual knowledge transfer focuses on knowledge distribution, where the supplier of knowledge acts. Alternatively, specific knowledge should be supplied that answers a precise question. The demander of knowledge becomes the actor. In addition, with respect to soil matters learning instead of passive uptake of knowledge is important. Within SKB, the principle of information-on-demand and the transfer of practice and experience needs to be further developed and put into place.
> (Van der Vlist et al. 1998)

Although SKB was an improvement in terms of approaches towards the role of knowledge in complex problems, a closer look at it reveals that it is a variation of the instrumentalist theme; more communication and more effort are assumed to be the keys to success. Supply-driven knowledge development is replaced by demand-driven knowledge development. The assumption is that the construct of 'consortia' is sufficient to establish an environment within which knowledge becomes an integrated part of the process. One of the figures in the business plan illustrates SKB's approach to types of knowledge and knowledge transfer.

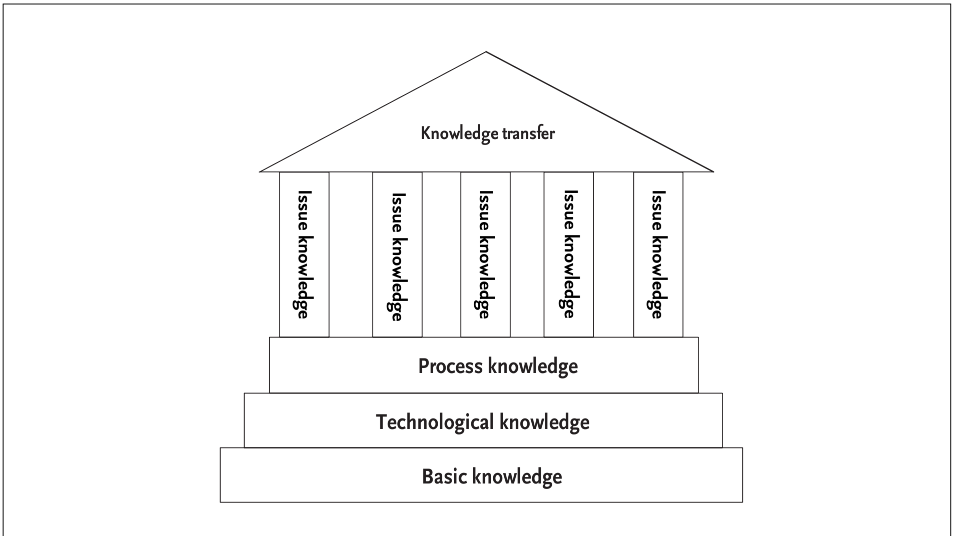


Figure 4.3.5 Types of knowledge developed within SKB (Van der Vlist et al. 1998)

SKB distinguished between basic -, technological -, process -, and issue knowledge, without any further explanation of what these types of knowledge are, how they are produced, assessed and related. The 'roof' (knowledge transfer) suggests that these types of knowledge meet and merge through knowledge transfer. It is left up to the market to establish this integration.

In the third section of the literature review in Chapter 3 a body of literature was discussed on the knowledge infrastructure to produce answers to problems cast in complex systems. This literature on 'Mode 2' and 'post-normal science' has recognised the nagging issue of how to organise quality control. This is one of the most difficult problems to be solved, and it is illustrative of the lack of ideas how to organise this that the SKB business plan does not address this issue. The business plan is also explicit about the importance to integrate several disciplines. Figure 4.3.6 (taken from the business plan) casts no doubt about how to interpret this integration: as an extension of the natural sciences.

Although the business plan formulates the development of social science knowledge, this soon was considered to be too difficult or ambitious (SKB newsletter 2000). This underlines the apparent difficulty for research programmes to enact knowledge transfer together with an approach to interdisciplinary knowledge development. The strategies SKB proposed for knowledge transfer further support the interpretation that SKB was designed according to an instrumentalist perspective: more exchange, more meetings, more documents, more newsletters as a strategy to improve knowledge transfer.

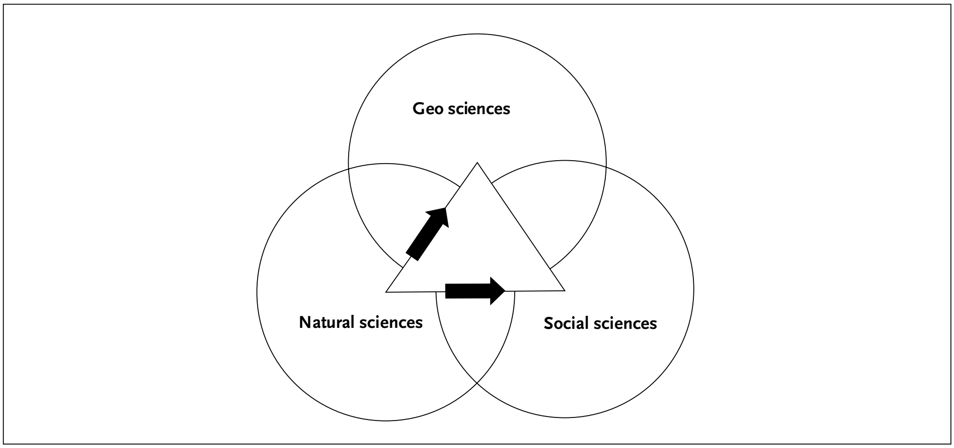


Figure 4.3.6 Disciplines and developments (Van der Vlist et al. 1998)

4.3.7 The institutional context in episode 3, an integration

The institutional context in this episode can be characterised as a search for and implementation of new steering concepts for policy and research. Multifunctionality as the guiding principle for soil policy is now (in practice) replaced by function-based assessments of soil quality. Active soil management, introduced in the previous episode guides many of the developments as a management concept. The role of central and de-central government is revised, after successful attempts by the Association of Netherlands Municipalities (VNG) to open up the decision-making and standard-setting processes.

In this third episode, new research programmes are developed that are based on a changed view on the development of usable knowledge. Public-private funding mechanisms and innovative programme organisations are developed. This third episode ends with the publication of the final report of the policy renewal in 2000.

Table 4.3.2 The three dimensions of the institutional context in the third episode. For each dimension critical events, achievements and developments that have been explained in the text above are listed in the table.

Regulative	• Revision Soil Protection Act (1994) • Cabinet's position (1997) • Building Materials Decree (1999)
Cognitive	• Function-based quality • Risk approach • Multifunctionality
Normative	• Active soil management • Soil policy renewal: BEVER, six aspects from Target Perspective • Soil research programmes (PGBO, NOBIS, SKB)

CHAPTER 5

Reference values for soil quality

Chapter 4 described the recent history of soil policy and science. Three episodes were distinguished. In each of these episodes a new set of standards for soil quality was developed. In the present chapter, the labelling of usable knowledge for the development of the reference values in the first episode is analysed. In Chapter 3 the concepts *boundary work, labelling usable knowledge, regulatory practice and institutional context* were brought together. The line of reasoning in that chapter was that the arguments used for labelling usable knowledge had to be related to the dimensions of the institutional context within which these standards were developed in order to legitimise this labelling. This chapter answers the research questions 2 and 3 for this fist case study:

2. What knowledge is labelled as usable knowledge?
3. What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context?

Demarcation of the case

The case study is demarcated between publication of the Discussion Memorandum on Soil Quality, containing provisional reference values in 1986 and publication of the reference values for soil quality in 1988 (Min.VROM 1988). During the discussions over the Soil Protection Act in the Lower House from March 1985-June 1985, a list with values representing 'good' soil quality (goede bodemkwaliteit) was drawn up. In 1986, the Discussion Memorandum on Soil Quality (Discussienotitie Bodemkwaliteit) was published containing a list with provisional reference values

(Min.VROM 1986). The document was prepared by a small group of policy staff members and proposed standards for the concentration of metals below which soil could be qualified as having a good soil quality. These provisional reference values were based on data from inventories of metal concentrations in soil samples. These studies were carried out for agricultural lands and 'relatively undisturbed areas' in the Netherlands and abroad in the 1970s and 1980s (Edelman 1984; Kabata-Pendias 1984; Van Driel and Smilde 1981). After publication of the provisional reference values, the Provisional Technical Committee on Soil Protection, (PTCSP) was invited to critically review this Discussion Memorandum on Soil Quality and provide advice to the minister about the reference values.

In its advice, the committee was critical about the method for calculation of the provisional reference values and prepared a detailed alternative (VTCB 1986a). For this alternative the scientific data that were used for the preparation of the provisional reference values were subjected to an elaborate statistical analysis. This resulted in a detailed classification of soil types, and formulas to derive standards for each soil type. The ministry simplified this alternative on some points, but for the most part adopted it. The reference values were published in the progress report of the Environmental Programme in 1988 (Min.VROM 1988). In this report, the reference values were defined. From the definition it appears that reference values were meant to operationalise the principle of multifunctionality.

> A soil that meets the reference values can be considered in general to be multifunctional according to the current scientific knowledge; this means that no adverse effects of the specific substances are expected.
> (Min.VROM 1988)

As shown in Chapter 4, initially the principle of multifunctionality was defined at an abstract level only, and not further operationalised.

5.1 From context to case

Before proceeding with the details of the case studied, a reiteration is given of some points from the first episode in Chapter 4, that are of special relevance here. In 1972, the department on Soil was established within the Ministry of Public Health and the Environment. The department handled a variety of issues that were not covered by the other departments (Water and Air) within the Ministry. Notably, radiation, noise and toxic substances were amongst these. Only after the discovery of landfills and waste dumps throughout the country, additional resources became available to increase staff. Soil protection was rocketed on the political agenda upon the discovery of a large polluted suburb in April 1980. By then, the head of the department responsible for soil policy at the ministry was very well aware of the need to hire staff with technical knowledge on soils. He assigned a significant part of the research budget to a soil research programme, and involved his staff members in the supervision of research projects. Also, the TCSP was established in the Soil Protection Act as an advisory committee to the government concerning technical aspects of soil policy. At the time of the quest for reference values, the soil department was an enthusiastic and dedicated group.

In the first episode, soil policy and research gained a position relative to other environmental compartments and relative to flanking policy fields like agriculture. Contacts between science and policy developed and intensified. The development of the regulatory framework and of the relation between soil scientists and policymakers was facilitated by the vaguely formulated guiding principle of multifunctionality. This principle served as a boundary object to unite science and policy. The sense of urgency to develop a legal framework created a momentum to develop soil standards. In the early years of environmental policy, standards were already referred to as adequate instruments to regulate the use of environmental and natural resources.

Table 5.1 The three dimensions of the institutional context in the first episode as described in Chapter 4. Critical events, achievements and developments are given for each dimension.

Regulative	• Interim Soil Pollution Act (1983)
	• Soil Protection Act (1987)
Cognitive	• Multifunctionality
Normative	• Carving out a department (sector) for soil quality at the Ministry of Public Health and the Environment
	• Disputes between ministries over authority to regulate soil quality
	• Establishing the Technical Committee on Soil Protection
	• Soil research programmes (Soil Protection, Soil Ecology, Netherlands Integrated Soil Research Programme SPBO)

This chapter first gives a concise chronological overview of the case, followed by an analysis of the labelling of usable knowledge.

5.2 Current state of knowledge

Before soil pollution became a political and scientific issue, soil was predominantly perceived as the carrier for civil works on roads, dams and dikes and as substrate for agricultural production (production function). Relevant scientific research on soils was concentrated at Wageningen Agricultural University, at the Institute on Soil

Fertility (IB) and at the National Institute for Nature Management (RIN). Focus was on the abiotic, chemical and physical properties of soils. Scientific findings were developed in the context of agricultural policy. Knowledge on the effects of potentially toxic substances on the soil ecosystem was limited at that time to relatively small groups in Wageningen and at the Free University in Amsterdam. At the Institute on Soil Fertility (IB) and the National Institute for Nature Management (RIN) research was carried out that measured concentrations of metals in soil. In 1979, a research project was started and conducted by Edelman at the National Institute for Nature Management. It was funded by the Research Programme Soil Protection (see Section 4.1.4.) from the Soil department from the Ministry of Public Health and the Environment. The results of this study were published as a list of concentrations of metals from the sampled sites (Edelman 1984). At the Institute on Soil Fertility the researchers Van Driel and Smilde (1981) had assessed the levels of potentially toxic substances in agricultural soils in 1981. International studies were available with similar data on concentrations of metals in soils (Kabata-Pendias 1984). In a speech held in 1986 one of the ancestors of Dutch soil science, De Haan, summarised the state of knowledge at the time.

> While soil biology is [in 1986] a more or less underdeveloped area, soil chemistry and soil physics have unravelled the abiotic soil processes in depth. An important drive for this was the increase in knowledge required for the function of soils in vegetable food production.
>
> It is worthwhile to note that physical, physico-chemical and chemical processes have received much more attention in the past compared to biological processes. This might be related to the higher complexity of processes within and among living systems and organisms.
>
> We regret this gap in knowledge on these processes now that protection of the environment calls for quantitative information on these biological processes.
> (De Haan 1986 p.18)

De Haan qualified the then current knowledge as insufficient for a proper assessment of effects. In the interim period between this qualification (1986) and the publication of the reference values in 1988, no significant changes or breakthroughs in scientific knowledge occurred.

> While quality assessment on the basis of effects is not yet possible, and it is also not deemed wise or correct to suggest that sufficient knowledge is available to do so, … the first steps towards a quantitative assessment of soils could be taken.
> (De Haan 1986 p.18)

Apparently, at the time the reference values were being developed, the available knowledge did not meet the required needs. Here it is relevant to remember the text in the policy document 'Environmental Quality' mentioned in Chapter 4.

> …whenever it is acknowledged that there are gaps in knowledge, it can still be desirable to develop standards.
> (Min.V&M 1976b p. 29)

5.3 Setting the standards and labelling usable kowledge

In this first case, the labelling of usable knowledge was not a matter of choosing between alternative bodies of knowledge. There were simply no alternatives. The Edelman dataset from the research project at RIN, together with the datasets by Van Driel and Smilde and comparable international work, represented the body of knowledge available on the concentrations of substances in soil. In this section an explanation is given of this scientific knowledge available at the time and eventually labelled as usable to develop the reference values. Also, the arguments that are used to connect the available knowledge to the qualitative wording of the reference values are given in Sections 5.3.1 to 5.3.3. In addition, the stepwise production of the reference values with a focus on the scientific models and calculations made to establish the reference values as they were published in 1988 is described in these sections. Two proposals were made, before the publication of the third proposal. The following sections also describe the main differences between the subsequent versions.

5.3.1 Provisional reference values

The initiative for the development of the reference values and for labelling usable knowledge was taken by the Ministry of Public Health and the Environment. In 1986, the Soil Protection department published a Discussion Memorandum on Soil Quality, containing provisional reference values. The staff member at the ministry who did most of the work for the Discussion Memorandum on Soil Quality made it clear that he used his scientific training as an ecologist to assess the usability of the Edelman data (see above). He was surprised about the relative homogeneity of the data, having in mind the data he collected himself in the research for his PhD thesis. This is a clear example of the paradigmatic differences between scientific fields about dealing with variety and uncertainty. Judging the available knowledge from his ecological perspective made it possible to take the dataset by Edelman into consideration and evaluate its usability. With his argumentation this scientific knowledge was labelled as usable knowledge.

In the Discussion Memorandum on Soil Quality, the provisional reference values were based on the concept of binding capacity. The variety of soil types in the Netherlands was taken into account by distinguishing between lutum and organic matter. Several other soil characteristics were considered too variable to base such assessment on (Min.VROM 1986 p. 8). In the Discussion Memorandum on Soil Quality it was proposed that organic matter contributed three times as much to binding capacity compared to lutum content. The following formulas are from the PTCSP advise. In a formula:

$$C_{sample} = 1.5\ OM + 0.5\ L$$

C is binding capacity; OM is the organic matter mass percentage and L is the lutum mass percentage. With this formula, soil types were characterised for their metal-binding capacity. The relation between lutum and organic matter was assumed to be independent of the percentage of any of these concentrations. With this formula a continuous system for soil types was proposed. To facilitate comparisons between different soil types throughout the country, standard soil was defined as soil with a binding capacity, C equal to 27.

$$C_{standard\ soil} = 27$$

Measured concentrations, as well as organic matter and the lutum content of the samples taken by Edelman were used to calculate metal concentrations in standard soil using the following formula:

$$Metal\ concentration_{standard\ soil} = (C_{standard\ soil} / C_{sample})\ Metal\ concentration_{sample}$$

Calculating these concentrations for ‘standard soil’ resulted in a wide range of values for every substance. The provisional reference values were set at a level that was:

> …not exceeded in most of the sampled terrains.
> (Min.VROM 1986 p. 8)

This meant that 90% of the calculated concentrations were below the reference values. These provisional reference values were published in the Discussion Memorandum on Soil Quality.

Table 5.2 Formulas for the calculation of the provisional version of the reference values and the values as calculated for standard soil (Min.VROM 1986).

	Discussion Memorandum on Soil Quality (reconstruction in (VTCB 1986b p. 20)	Provisional reference values Concentrations in mg/kg dry soil (Min.VROM 1986)
Cr	30 + 2 L	125
Ni	15 + L	50
Cu	8 + 0.6 L	30
Zn	50 + 3 L	180
Cd	0.3 + 0.02 L	1.0
Hg	0.08 + 0.006 L	0.30
Pb	30 + 2 L	100
As	8 + 0.6 L	30

5.3.2 Alternative developed by Provisional Technical Committee on Soil Protection

In PTCSP's advice, the Working Group on reference values commented on the approach as outlined above and developed an alternative. The advice was written down in a lengthy (95 pages) and impressive document with appendices (135 pages in total), providing the details of calculations, tables and figures. Technically, the most critical comments in the advice concerned the proposed continuous system for soil types. Soil scientists at Wageningen Agricultural School argued that a continuous system was incorrect. They compared the available data, (the same data as used for the Discussion Memorandum on Soil Quality) with the proposed continuous system ($C_{sample} = 1.5\ OM + 0.5\ L$). They showed that measured values in sandy soils (low organic matter and low lutum content) from the Edelman data exceeded the proposed reference values, while at the same time it was exactly the other way around for peaty soil (i.e., soils with a high organic matter content); for those soils, the proposed reference values significantly exceeded the measured concentrations, sometimes by a factor 100. To overcome this, the PTCSP urged to differentiate between mineral and peaty soils for all substances (except for chromium (Cr) and nickel (Ni)). The organic matter content (OM) of mineral soils is - by definition - less than 250 g/kg. The organic matter content of peaty soils is - by definition - equal to or higher than 250 g/kg (VTCB 1986b p. 15). The second comment in the advice was that the approach proposed by government did not differentiate between the substances. The PTCSP urged to apply substance-specific formulas to calculate reference values.

The two modifications resulted in the formulas per substance for the peaty and mineral soil given in Table 2. The modifications were based on a differentiation between the two meanings of lutum and organic matter as presented in the textbox at the beginning of this section. Scientists urged for differentiation where policy-makers stressed similarity.

Table 5.3 Relations between concentrations of elements and lutum and organic matter content for mineral, peaty and standard soils as proposed by the PTCSP (VTCB 1986a).

	Mineral soils	**Peaty soils**	**Standard soil (OM = 10%, L = 25%)** Concentrations in mg/kg
Cr	50 + 2 L	50 + 2 L	100
Ni	10 + 1 L	10 + 1 L	35
Cu	6 + 0.6 L	40 + 0.6 L	55
Zn	50 + 3 L	50 + 1.5 (2 L + OM)	140
Cd	$0.6 + 6 \times 10^{-3}$ L	$0.9 + 6 \times 10^{-3}$ (L + 3OM)	1.23
Hg	$0.15 + 2 \times 10^{-3}$ L	$0.25 + 1 \times 10^{-3}$ (2 L + OM)	0.85
Pb	35 + 1 L	75 + 1 (L + OM)	110
As	8 + 0.4 L	25 + 0.4 L	35

The two versions (provisional reference values proposed by the ministry and the alternative developed by scientists in the PTCSP) had in common that lutum and organic matter content were used as the key soil characteristics to base a standardisation of soil quality on. However, they had different reasons for this. The argumentation in the Discussion Memorandum was that lutum and organic matter content were crucial to the binding capacity of soils. This is a relevant characteristic when analysing anthropogenic enrichment on top of the naturally occurring concentrations, but not if we consider soils that are sampled from 'relatively undisturbed areas' that are assumed to contain only, or mainly, naturally occurring concentrations. In their proposal, PTCSP started from the notion that the samples were taken to represent naturally occurring metals, and hence should be understood by selecting lutum and organic matter because they cater for most of the naturally occurring presence of metals. For instance, one of the main constituents of mineral soils is quartz and quartz naturally contains a high concentration of heavy metals. In PTCSP´s advice, focus was on selecting the "right" classification characteristic, according to scientific standards.

Lutum and organic mater content are two important characteristics of soils that yield different soil types. An explanation of the importance of these characteristics is given in the box below.

Lutum and organic matter

For an understanding of the scientific knowledge that was twisted and turned in order to connect it to the qualitative formulations of the reference values, it is important to have some basic knowledge about two soil characteristics: lutum and organic matter content.

The capacity of soils to bind cations (positively charged ions that are predominant in fertilisers; heavy metals are often present in the soil as cations) determines the effects of fertiliser addition or presence of metals on plant growth. Organic matter binds these ions. Depending on other circumstances these ions become available for plant uptake. Lutum also has this binding capacity, but far less than organic matter. Binding capacity differs per substance. The mass percentages of lutum and organic matter together determine the binding capacity of soils for any given substance. A low binding capacity of soil implies a high availability for uptake by plants and animals, as well as a risk of washing out. Sandy soils have a smaller binding capacity than peaty soils. Therefore, plants can take up potentially toxic substances more easily from sandy soils than peaty soils. Binding capacity was identified as an important soil characteristic in studies into the effects of added nutrients and fertilisers on agricultural production. Binding capacity is a relevant characteristic to understand the effects of added substances.

Some metals are present in the rock material from which soils are formed, others occur only through anthropogenic enrichment. The natural occurrence of metals is, like binding capacity, related to the lutum and organic material of soil, as these in turn are related to the rock material from which this soil was formed.

In the case of a natural presence of metals, their concentration is related to the lutum and organic matter content of soil because they relate to the rock material. In the case of anthropogenic enrichment of metals, their potential effects are related to the lutum and organic matter content of soil because they determine the binding capacity of soil.

Lutum and organic matter content of a soil translate into the variety of soil types. Clay soils have a high lutum content. Peaty soils have a high organic matter content. Mineral soils have a low organic matter content. Sandy soils have a low lutum and a low organic matter content.

The double meaning (binding anthropogenic enrichment and natural occurrence) of lutum and organic matter content dominated the discussion about the appropriate approach to calculate reference values. Since the production of reference values, this double meaning has become a millstone for the implementation of standards as it is difficult to establish appropriate relations to differentiate between the two, and difficult to translate into policy objectives (see for instance (Van Straalen and Souren 2002) on this issue).

5.3.3 Final version

In 1988, the reference values were published. The alternative prepared by the PTCSP was partly adopted; substance-specific formulas were used but the differentiation between mineral and peaty soil was not adopted. The lumping of the two categories (mineral and peaty soil), implied that for copper and arsenic, both lutum and organic matter had to be included in the formulas.

Table 5.4 Formulas for the calculation of the final version of the reference values and the final reference values as calculated for standard soil (Min.VROM 1988) .

	Formula	**Reference values$_{\text{standard soil}}$**
Cr	50 + 2 L	100
Ni	10 + 1 L	35
Cu	15 + 0.6 (L+OM)	36
Zn	50 + 1.5 (2 L +OM)	140
Cd	0.4 +7 x 10^{-3} (L+3 OM)	0.8
Hg	0.2+ 1.7 x 10^{-3} (2 L+OM)	0.3
Pb	50 + L + OM	85
As	15 + 0.4 (L + OM)	29

Although some scientists were agitated about the final published reference values, there was also agreement that an assessment was urgently needed. De Haan, as a prominent member of the PTCSP and leading scientist from Wageningen University labelled the available knowledge as usable knowledge with the following statement:

> …the increasing degree of soil pollution does not allow for any further delay of legal regulations for soil protection. And of course, it would be extremely helpful for soil protection to avail of an assessment framework for soil quality.
> (De Haan 1986 p.28)

He referred to the development of the Soil Protection Act and the position of soil policy in his approval of the present approach.

5.3.4 A comparison

Table 5.5 and 5.6 give an overview of the substance specific formulas developed to calculate the reference values and the resulting values for standard soil. The formulas used to calculate reference values in the final version are in some cases equal to previous versions (Cr, Ni, Zn), but in other cases, they are adaptations of the previous versions. A comparison of the concentrations for the metals in more extreme soil types like sand, clay and peat is given in Table 5.6, and reveals these differences.

Table 5.6 Reference values for standard soil. For the provisional reference values (column 2) standard soil is defined as soil for which the mass percentage of lutum + 3 times the mass percentage of OM equals 27. For the alternative approach and the definite reference values (columns 3 and 4), standard soil is defined as soil with a mass percentage of lutum of 25 and a mass percentage of organic matter of 10. The figures in the 3rd column (alternative approach developed by PTCSP) are calculated with the formulas for peaty soil given in this alternative approach (see Table 5.5).

	Provisional reference values (Min.VROM 1986) Concentrations in mg/kg	**Alternative approach (VTCB 1986a p. 26)** Concentrations in mg/kg	**Reference values (Min.VROM 1988)** Concentrations in mg/kg
Cr	125	100	100
Ni	50	40	35
Cu	30	30	36
Zn	180	120	140
Cd	1.0	0.8	0.8
Hg	0.30	0.2	0.3
Pb	100	65	85
As	30	20	29

The differences between the values for standard soil are slight as can be read from Table 5.6. Apparently, for standard soil, the different approaches lead to comparable concentrations. A comparison of the concentrations for the metals in more extreme soil types like sand, clay and peat reveals the differences between the approaches (see Table 5.7). In Table 5.7 the column ‘standard soil’ is repeated from Table 5.6. The columns ‘sand’, ‘clay’, ‘peat’, concentration values are calculated above which the criterion for multifunctional soil quality is exceeded. For most substances, the more organic matter, the higher (i.e. less strict) the standards are.

Table 5.7 Calculated concentrations for metals for standard soil, sand, clay and peat adapted from (VTCB 1986 p. 26). The characteristics of these soil types are defined in PTCSP 1986 (VTCB 1986 p.19). *For the first and third column, standard soil has a C value of 27; in the second column, standard soil has a C value of 25. Concentration in mg per kg.

	Standard soil*			Sand (5% OM, 3% L)			Clay (5% OM, 57% L)			Peat (59% OM, 3% L)		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Cr	125	100	100	42	52	56	170	160	164	480	108	56
Ni	50	40	35	17	21	33	67	64	67	170	43	13
Cu	30	30	36	10	16	19.8	40	48	52	100	32	52
Zn	180	120	140	62	60	66.5	240	192	228	600	129	148
Cd	1.0	0.8	0.8	0.3	0.3	0.5	1.2	1.0	0.9	3	0.9	1.7
Hg	0.30	0.2	0.3	0.1	0.1	0.4	0.4	0.3	0.4	1	0.2	0.3
Pb	100	65	85	33	34	58	133	104	112	330	70	112
As	30	20	29	10	10	18	40	32	40	100	22	40

These figures illustrate that the differences between the three stages of development of the reference values become visible only when looking at different soil types. The main difference between the respective versions is in the classification of soil types.

5.4 From case to context

The development of the reference values affected the context of standards for soil quality. The impact of the labelling of usable knowledge and the establishment of the reference values are regulative, cognitive as well as normative. In the regulative dimension the reference values introduced effect-oriented assessments and created meaning to the role of standards in soil protection and pollution policy. Cognitively, the reference values gave meaning to the principle of multifunctionality and affected the research agenda. In addition, through the development process of the reference values, the relations between science and policy in such technically complex matters were established, as well as the relation between the different ministries and policy fields.

5.4.1 *Giving meaning to the role of standards in (soil) policy*

In the Priority Memorandum on the Environment (Min.V&M 1972) the choice of standards as important instruments in policymaking was motivated. One of the reasons for developing standards was the awareness that there are 'Limits to growth' and in the document there were ample references to the international report by the Club of Rome (Meadows 1972) as well as to the UN conference in Stockholm (1972).

> Standards are perceived as instruments that provide a frame, within which economical, technical and social processes can develop.
> (Min.V&M 1972 p. 46)

Most prominent in the Priority Memorandum was the motivation for setting environmental quality standards. This motivation is abstract. Further reference to the role of standards in policy development and implementation is scarce and not very specific, as the above quote illustrates. In 1976, a second seminal policy document was published: Memorandum Environmental Health Standards (Min.V&M 1976). The aim of this document was to summarise the current line of thinking about quantitative standards, and to explore the possible roles of standards in environmental policy. However, the document did not produce anything other than a list of different types of standards: emission, immission, process and product standards and an exposé about the importance and relevance of such categorisation.

From the above, a picture emerges of a newly developed instrument of which the ultimate consequences during implementation were not yet fully thought out or worked out beforehand. In the process of developing the reference values concern over implementation aspects popped up regularly, but were not an explicit subject of debate. It seems as if that is considered as something that has to be solved in practice, and should not be discussed openly.

Only after the hurdle of deriving a list with standards was taken, space was created to discuss these aspects. This was done prominently at the symposium 'Environmental Quality' in December 1986. This symposium was organised by the PTCSP. Here, Wessels Boer, staff member at the ministry and responsible for standard setting and substances, tried to analytically unravel the confusion by positioning standards along the problem of the life cycle chain (VTCB 1986c). In doing so, he pulled the standards out of the scientific and technical sphere and positioned them as instruments in policy processes. The policy process is depicted as consisting of four stages: Problem recognition, Policy formulation, Solution, and Management. He positioned standards at each of the transitions and called the respective roles of the standards: problem setting, task setting and management instruction. After that, he explained that soil policy was at the start of the policy formulation stage. The reference values therefore had a problem-setting role. They helped to indicate the nature and size of the problem and help to formulate policy. In the second part of his speech he sketched the future of soil policy and the role of standards therein and foresaw that reference values would get a more task-setting role in the following stage of the policy cycle. His stage-wise interpretation of policy problems was adapted from Winsemius, the then minister responsible for environmental policy (Winsemius 1986) whose influential book in which he propagated a management approach to environmental problems, was about to be published. The practical need to discuss the role of standards became urgent as it turned out that the reference values were used by soil treatment engineers. To them, the reference values were target values for soil cleanup. Within the ministry there was concern about this task-setting use of the reference values.

After a few years of experience with the reference values, several publications addressed the confusion about the role of reference values (CRMH 1987, 1991; TCB 1990). TCSP's annual report (1990) addressed the fact that policy principles can be interpreted in a hierarchical order from concrete to abstract. At the highest level, policy principles are ethical, referring to a deeply rooted notion. At the intermediate, strategic, level principles translate the ethical principles to guidelines for policy on a specific issue. Finally, there is the operational level, with policy principles for concrete policy actions, programmes or projects. The principle underlying the reference values, multifunctionality, is a strategic principle, more than that it is an operational principle. This issue is intimately related to Section 5.4.2.

5.4.2 Giving meaning to the principle of multifunctionality

In the policy document Preliminary Soil Policy Plan (Voorlopig Indicatief Meerjarenprogramma Milieu-Bodem) (Min.VROM 1983), the principle of multifunctionality was drafted, although it appeared in a slightly different form in earlier documents (see Chapter 4).

Multifunctionality was defined as the potential of soils to fulfill all possible functions given the location-specific conditions. The following different functions were distinguished: carrier of ecosystems, water storage, production function (agriculture), the mining of minerals and the ecological function. Given the high turnover of land use (1% per year in the early 1980s), the high groundwater tables and the persistence of soil pollution, the capacity of soils to fulfill each of these functions had to be maintained. The aim of the soil protection policy was to maintain such a quality that it maintained its potential for multifunctional use. In other words, soil quality was defined at a generic level, without any contingency on land use, or land use plans. This implied that cleanup of any soil had to result in soil of good soil quality. The concept is predominant in both the Discussion Memorandum, and in PTCSP's advice. It functioned as a boundary object to unite policy and scientific effort. However, a consistent and common definition was never developed. Once the size of the problem had become clear, it was also obvious that treating all sites up to the level of guaranteed multifunctionality would be a very costly operation.

Although there was some dissent over how to interpret multifunctionality, it was broadly accepted as an overarching principle. Its cognitive dimension contributes to a context in which there is sufficient consensus to produce reference values. The objections from some scientists involved have not prevented the majority of the actors involved from being enthusiastic about this first step towards the production of soil quality standards. The PTCSP was modest in its comments on the implications of adopting the methodology proposed in the Discussion Memorandum. The PTCSP was not explicitly invited to comment on these implications of the provisional reference values, although one of the aspects in the letter by the minister requesting its advice created room for taking this into account:

> The advice would have to deal primarily with the following aspects:
> …
> -the height of the provisional reference values, in relation to their goal, namely the provisional and partial specification of a multifunctional soil quality, and within the restrictions as given in the Discussion Memorandum.
> (VTCB 1986a)

The PTCSP addressed this aspect and identified inconsistencies in the definition of the principle of multifunctionality as provided in a sequence of policy documents.

5.4.3 Interactions between science and policy over complex technical issues.

In 1985, the initiative to develop standards was taken by policy. At that time, and given the context in which there was a large sense of urgency to proceed with developing soil policy, policymakers took the initiative for the formulation of standards and proposed to have them reviewed by the scientists. This was the reason for the main writer of the Discussion Memorandum on Soil Quality to develop the provisional reference values. The scientific community at Wageningen University sceptically welcomed the energetic action taken by the ministry:

> The rumour spread throughout Wageningen that there was a policy document being produced containing reference values…

The scientific community felt surpassed, and was highly motivated to provide a critical review of the provisional reference values through the PTCSP. One of the scientists involved argued:

> We were motivated to show those policymakers how to derive standards!
> (Interview quote scientist at Wageningen University at the time)

Policymakers considered it crucial to create 'a coalition of engaged and friendly scientists' (see the description of the first episode in Chapter 4). For the other environmental compartments, air and water, scientists were already involved in providing information to policymakers through the governmental research institutes. For the relatively new policy issues of soil protection and soil pollution, scientists had to be freed from their ties to (mainly) the Ministry of Agriculture and Fisheries. Close relationships with scientists were considered important. In the early 1980s, there were times that the minister responsible for the Environment had to answer questions about a range of aspects related to polluted soils every day. To be able to provide him with convincing arguments, it was necessary to avail of a 'coalition' that could provide the required information. However, at the same time, the 'sense of urgency' among policymakers to speed up the progress of developing soil policy made them decide not to wait for scientists to come up with a proposal for standards, because it would take far too long. The alternative was to take the initiative and organise a discussion about proposed values. As one of the then policy staff members stated in the interview:

> There was a lot of discussion about the details. Fine, but ultimately we had our standards!
> (Interview quote policy staff member at the time)

Policymakers highly valued scientists' commitment in deriving standards, and considered it important to avail of technical knowledge. This, however, did not imply that scientists were invited first to come up with a proposal. At stake here is the role in deriving standards and how the roles should interact. The relation between scientists and policymakers is negotiated here. As explained in Chapter 4, scientific knowledge was considered very important to the further development of soil policy (see for instance in the Priority Memorandum on the Environment and the Memorandum on Environmental Health Standards (Min.V&M 1972, 1976b). Research programmes were formulated with large financial contributions from the Ministry of Public Housing, Spatial Planning and the Environment, for example the Research Programme Soil Protection and the Netherlands Integrated Soil Research Programme (SPBO). As we will see in Chapter 6, for the development of target and intervention values, scientific knowledge was more explicitly used and already included in the preparation and formulation of policy principles (notably the risk approach).

5.4.4 Positioning of soil relative to other policy fields and ministries

Through the definition of multifunctionality, soil policy was related to water and agricultural policies. In these policy fields, quality standards had been formulated as well. In agriculture, the LAC standards[13] related the presence of substances in agricultural fields to residues on crops. Any proposed set of standards for soil quality had to be compatible with these standards to assure coherent environmental policy. The reluctance of the other ministries to develop an overarching soil protection policy (see Chapter 4) made it difficult for the staff members who were preparing the Discussion Memorandum on Soil Quality to fine-tune the provisional reference values with, for instance, the LAC standards. The staff member stated in his interview:

> Through informal talks and phone calls I got the impression that we were not beyond the LAC standards, and that was interpreted as support for the provisional reference values.
> (Interview quote policy staff member at the time)

The production of the provisional reference values was of strategic importance to the position of soil policy. It required a mobilisation of scientists who until then were mainly related to the Ministry of Agriculture and Fisheries as this ministry provided the financing of Wageningen Agricultural University. It was an offensive, initiative from the Ministry of Public Housing, Spatial Planning and the Environment that confronted the other ministries to follow and answer the questions and requests, especially as it enacted the importance of the overarching Soil Protection Act (see Chapter 4 for the relevance of this act).

5.4.5 Classification of soil

Chapter 1 introduced the objectives of this research and provided some theoretical background on standards as instruments. The literature discussed in Chapter 1 makes it clear that standards classify and simplify. This is illustrated in Figure 5.1 below, which explains what reference values 'do' to soil quality. Reference values classify soil into 'clean' and 'polluted'.

13 LAC standards are standards developed by the Agricultural Advisory Committee on Environmental Contaminants (Landbouwadviescommissie Milieukritische Stoffen). These standards indicate concentration levels of residues on agricultural products

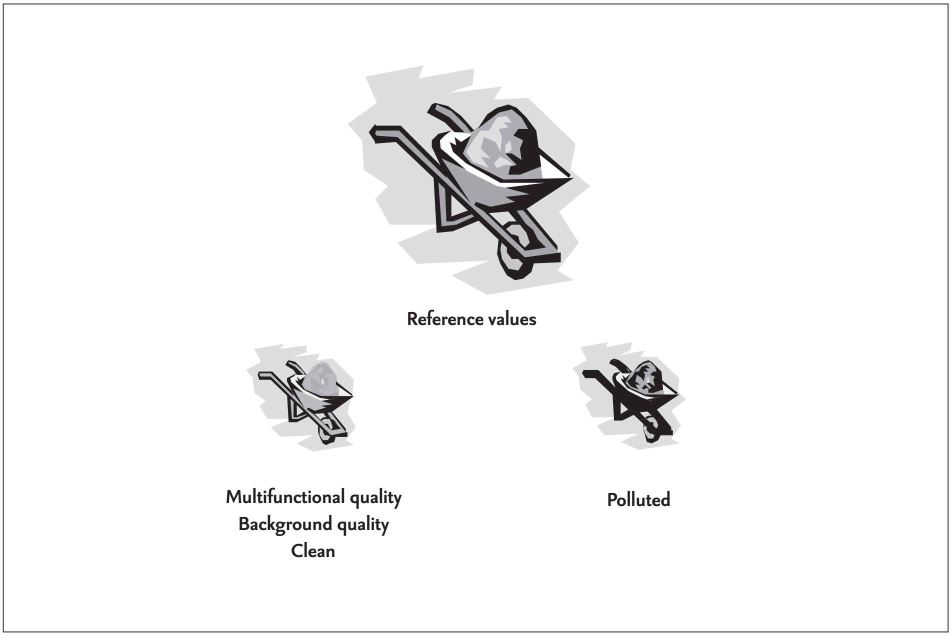


Figure 5.1 Classification of soil quality.

5.5 Conclusions

In Chapter 3, research questions 2 and 3 were formulated for the case studies.

2. What knowledge is labelled as usable knowledge?
3. What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context?

In this section the research questions are answered. The (disciplinary) background type of knowledge that is labelled as usable is described. Also the relation between the arguments applied in labelling and the institutional context is given.

Labelling of usable knowledge for the development of the reference values was a matter of justifying the adequacy of available knowledge to develop reference values and to satisfy the need for standards to assess soil quality. This first case study revealed the concerns from policymakers and scientists with regard to the production of standards for environmental quality. Policymakers were primarily concerned with the progress of soil policy, and at the same time suggested that the rationality of policy was guaranteed. The effort taken to connect the available knowledge to the principle of multifunctionality illustrates the importance attributed to scientific knowledge. Clearly, if this was considered less important, government could have referred to the available knowledge as indicative of the *reasonability* of the provisional reference values. Instead, government opted to have scientific knowledge indicating the *rationality* of soil policy. This opening was given for instance in the advice by the VCRMH in 1977 (VCRMH 1977). The VCRMH argued in its advice on the Priority Memorandum on Environmental Health Standards, that as the development of scientific knowledge trailed behind, standards for environmental quality should be based on *available* scientific knowledge.

The scientists' concern was about the rigor and exactness of the calculation of the numbers, and about their image as experts on 'getting it right'. In fact, the calculation of reference values was about establishing a soil typology based on lutum and organic matter content, whereas they were proposed to be about establishing a typology related to the effects of substances. The arguments applied in labelling all relate to the sense of urgency to move on with the development and implementation of soil policy as formulated in the Soil Protection Act (provisionally formulated in the Preliminary Soil Policy Plan). The strengthening of the regulative dimension of soil policy was used as an argument to label the Edelman data as usable for the development of the reference values

The arguments for labelling the available knowledge as usable knowledge in this case hardly concerned the adequacy of the proposed reference values as instruments indicating the boundary of good soil quality. The question what type of knowledge was required to translate multifunctionality was posed and answered in the appendices of the PTCSP report. The initial question by the ministry, asking for advice about the proposed reference values was not that broad, which was understandable, as the ministry was in a hurry. A considerable portion of PTCSP report sketched the contours of the type of knowledge required to formulate standards for effect-oriented policy. However, this body of knowledge was still incomplete and fragmented. The available knowledge and this policy wish (to avail of standards to assess soil quality) had to be matched.

Related to this first case study, research question 2 (What knowledge is labelled as usable knowledge?) can be answered as follows: the available knowledge was a set of raw, uninterpreted data. The data concerned measurements of concentrations of substances in relatively undisturbed areas. In addition to these data, an approach was developed and used to calculate reference values. This approach was based on chemical and physical knowledge concerning abiotic characteristics (lutum and organic matter content) of soil.

Research question 3 (What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context?) requires a more extensive answer. In the argumentation the regulative dimension is referred to explicitly. The need to develop standards is based on the conviction that these standards are required to confirm the position of soil policy and explicit reference is made to the Soil Protection Act. The reference to the cognitive dimension is less explicit. First, the principle was not yet specified in more detail. Second, the available knowledge did not relate to the principle clearly; the dataset gave no proof of the presence or absence of effects of substances. It was mere assumption that the concentrations measured in the relatively undisturbed areas did not have adverse effects. Policymakers took the lead in the matching process, by proposing an interpretation of these data. Justification for selecting this dataset as usable knowledge and of the specific interpretation of the data was sought and found in the sense of urgency to speed up the development of soil protection policy that was being experienced by all involved actors. Labelling usable knowledge in this case was a matter of formulating and interpreting the available knowledge as an operationalisation of multifunctionality. If that could be done, than it could serve as the scientific basis for the reference values. Scientists did not effectively complain that the proposed approach could not be used to distinguish between natural occurrence of substance and anthropogenic enrichment (see textbox above). They agreed very implicitly with this. The normative dimension is not referred to that much in the arguments, although the motivation of the scientists in the TCSP advice was to show policymakers how to calculate standards (see quote above).

CHAPTER 6

Target and intervention values

Effect-oriented environmental policy gained momentum in the 1980s as has been illustrated in Chapter 4. The reference values, discussed in Chapter 5 were the first standards supporting and constructing effect-oriented policy for soil protection. However, considerable work had to be done to develop a conceptual fully-fledged effect-oriented soil protection policy. Many questions regarding effect-oriented policy had not been answered. Problems encountered when operationalising effect-oriented policy were related to naturally occurring variation in ecosystems. In addition, Not all individuals are equally vulnerable to exposure to a substance, and not all species are equally vulnerable. Effect-oriented policy requires insight in this variation in natural systems. Another issue that had to be dealt with in effect-oriented policy was the effect itself: what effects are taken into account and to what level are they acceptable? In other words, effect-oriented environmental policy requires an understanding of the complexity of the naturally occurring variation in and among ecosystems and humans[14]. In the development of the reference values (Chapter 5) this understanding was insufficiently developed; the reference values were based on the *assumption* that the measured concentrations had no adverse effect. The values were not based on experimentally observed and verified knowledge. The challenge ahead was in the improvement of that understanding and in the translation of that scientific understanding into calculations for the height of the standards. The complexity of the soil ecosystem had to be unravelled to assess the risks of organisms and ecosystems to exposure to potentially toxic substances. The scientific questions raised by effect-oriented environmental policy contain methodological uncertainties (Funtowicz and Ravetz 1992). There are three kinds of uncertainty: methodological

14 This thesis focuses on natural systems; i.e., effects of substances on ecosystems.

uncertainty can be distinguished from technical and epistemological uncertainty. Technical uncertainty can be reduced by careful experimentation and technical improvements (i.e., increasing the accuracy of data). Epistemological uncertainty is most difficult to reduce as it requires shifts in scientific paradigms. Methodological uncertainty can be reduced by improving the understanding of the complexity. In most cases this requires a significant reduction of complexity. For instance, modelling, statistical techniques and simulations are well known techniques used to reduce methodological uncertainty. For a thorough theoretical background the reader is referred to the work by Funtowicz and Ravetz (1990; 1992) and Van Asselt (2000). The scientific work to be done to reduce methodological uncertainties is that of careful experimentation, modelling and adequate application of statistical techniques.

Demarcation of the case

The risk approach, published in 1989 by the Ministry of Public Housing, Spatial Planning and the Environment as an appendix to the National Environmental Policy Plan, is the starting point for this case study. The risk approach centres on the establishment of two risk levels; the Maximum Tolerable Level (MTL) and the Negligible Risk Level (NRL). The first, MTL, is 'defined' in the quote below. The NRL is determined at 1% of the MTL. The definition of the Maximum Tolerable Level contains a quantitative formulation that refers directly to the results of scientific work.

> The maximal tolerable level is reached when the concentration of a substance equals the calculated concentration at which 95% of all species in an ecosystem is protected.
> (Min.VROM 1989b)

Providing the scientific underpinning of the risk approach was the challenge to scientists in this second case study. Between 1987 and 1992 a series of scientific papers appeared on approaches to assess the fraction of species affected by the exposure to substances and on approaches to assess the effects on ecosystems. The 95% level used in the above definition is derived from this work. In 1989, the Health Council reviewed a selection of these models and advised on the method to be used to calculate standards (Gezondheidsraad 1989). In 1991, target values, for heavy metals were published (Min.VROM 1991). In 1994, the first set of intervention values was published for a limited set of substances, including heavy metals (Min.VROM 1994) The case studied in this chapter is demarcated in time, starting with the publication of the risk approach in 1989 and ending with the publication of the first set of intervention values in 1994.

6.1 From context to case

In the theoretical chapter it was argued that the arguments applied in labelling usable knowledge are connected to the institutional context. As we will see in this chapter, the arguments used to label a specific model to derive target and intervention values can indeed be related to the institutional context as they are described in the second episode in Chapter 4. In this section the major finds from that chapter are brought together. The second episode (1989-1994) could be characterised by reflection and renewal. During the second episode, extensive reflection took place on the first episode. The scientific basis for the reference values was criticised as well as the progress in soil policy in particular, the treatment of polluted sites. The renewal applies to the introduction of the risk approach as a new policy principle. The risk approach pertained to the notion that environmental effects are inevitable, to a certain level (see Chapter 4 for further explanation). The risk approach further brought about a harmonisation of policy for the environmental compartments, soil, water and air. Notably in the second episode, the relation between science and policy on standards for soil quality intensified. The groundwork was laid in the previous episode and consolidated in this second episode. Illustrative of the consolidation is that the Provisional Technical Committee on Soil Protection (PTCSP) was liberated of its Provisional status. Also, a large research programme, the Netherlands Integrated Soil Research Programme (SPBO) was established to develop basic knowledge on soils and the large policy programme for the development of Integrated Environmental Standards became operational. This policy programme involved a research project conducted at the National Institute for Public Health and the Environment (the RIVM). With the integration of the Soil Protection Act and the Interim Soil Pollution Act, the consolidation of soil policy within environmental policy became visible.

Table 6.1 The three dimensions of the institutional context in the second episode as described in Chapter 4. Critical events, achievements and developments are given for each dimension.

Regulative	• Integration of Interim Soil Pollution Act and Soil Protection Act (1994)
Cognitive	• Risk approach • Multifunctionality
Normative	• Active soil management • Increase in number of actors involved in policy development (notably the VNG, the IPO) • Integration of environmental policy fields • Criticism with regard to abstract and insufficiently operational principles guiding soil policy • Soil research programme (Netherlands Integrated Soil Research Programme SPBO)

6.2 Current state of knowledge

With the publication of the risk approach, environmental policy became explicitly effect-oriented. The maximum and negligible risk levels referred to effects on ecosystems. Crucial was the protection of ecosystems against adverse effects of substances. The development of standards for effect-oriented policy challenged science to develop insight in the complexity of ecosystems and in the mechanisms producing effects. In addition, science was challenged to establish the maximum and negligible risk levels for substances. This required a completely different approach as compared to the work done to establish the reference values (previous case). Where the scientific knowledge used in the previous case to derive reference standards was restricted to physico-chemical knowledge, the second stage in the development of standards required more ecological knowledge. And ecologists were eager to bring in their expertise, as can be read from the following quote.

> A number of functions are distinguished in the new draft Soil Protection Act, of which the ecological function is designated as the main one. In addition, the term soil quality takes up a central position. In this light, it is merely logical to use ecological parameters in the development of soil quality standards.
> (Denneman et al. 1985)

The paper by Denneman and co-authors was one of the appendices of PTCSP's advice on the reference values (VTCB 1986b). The contours of an ecological approach to establish risk levels were sketched in that advice. The appendix was written by ecologists and ecotoxicologists from the Animal Ecology group at Free University (Vrije Universiteit) in Amsterdam then chaired by Mrs. prof. Joosse. To understand the increased importance of ecological knowledge it is relevant to look at the principle of multifunctionality and the distinction of the different functions. In the explanatory statement to the Soil Protection Act it was concluded that the ecological function is the most vulnerable. Hence, protecting the ecological function was regarded as the most effective way to protect all functions. The assumption was that the functioning of ecosystems is not seriously affected as long as the structure of the ecosystem is not seriously (i.e. irreversibly) affected (Denneman and Van Gestel 1990 p. 6). That study by Denneman and Van Gestel provided the background for the development of the target values. The line of reasoning started from the notion that the ecological function of soil is determined by soil ecosystems. This implies that serious risks to the ecological function are serious risks to the soil ecosystem. This line of reasoning draws heavily on the ecological paradigm that structure, function and their interrelation characterise ecosystems. This reasoning was backed by referring to the seminal work of Odum (1971), an influential ecologist in the 1970s. In turn, a serious effect on the structure of the ecosystem is interpreted as a serious effect on the species composition. In Figure 6.1, the line of reasoning is summarised. This figure was already used in Chapter 4 to explain the background of the scientific effort in the second episode .The prevailing idea (notably within the Animal Ecology group) was that the crucial ecological function of the soil ecosystem was decomposition; the process in which organic material is degraded (fragmented), nutrients are mineralised, and then humus (soil organic matter) is formed. Through decomposition, the cycle of carbon, nitrogen and other organic nutrients is closed. The process of fragmentation of organic material received most attention, in part because that was the expertise of the group that conducted research with soil fauna, active in the first part of the decomposition process. Through toxicity tests with soil organisms it could be assessed under what concentration the ecological function would be adversely effected (Van Straalen pers.comm).

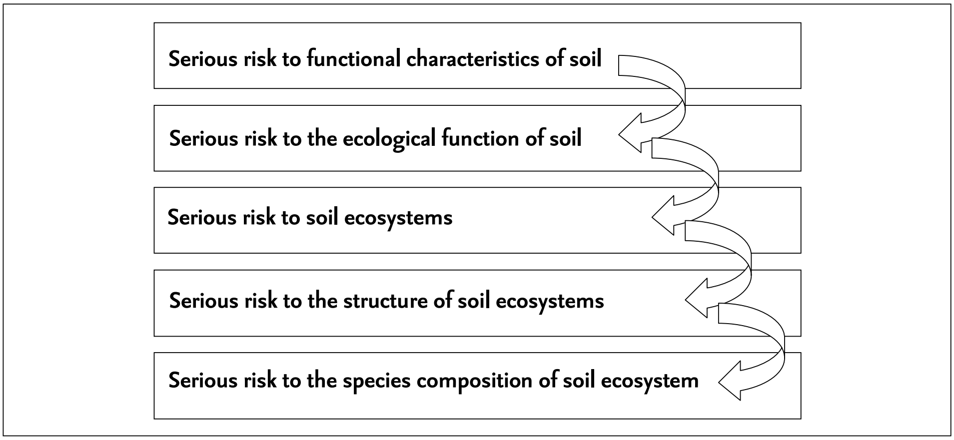


Figure 6.1 Operationalisation of 'Serious risk to functional characteristics of soil' (Denneman and Van Gestel 1990 p. 7).

This line of reasoning underlies the scientific work done in this episode. Toxicity tests on soil organisms were conducted, starting with tests on individual organisms and using the results as input to model the dose-response relation. As explained at the start of the chapter, the challenge for science in this case was to model the complex ecosystem and to deal with the methodological uncertainties typical for such undertakings.

There are at least three uncertainties in developing a scientific method: ecological complexity, experimental setup, and modelling/statistical assumptions. The ecological complexity relates to the complexity of ecosystems and their effects to exposure. Ecosystems are characterised by interactions between individual organisms and their biotic and abiotic environment. Establishing the vulnerability of a species to a certain substance requires an understanding of the ecology of the species, but also of the biophysical mechanism causing the effect of the specific substance in that organism. Scaling up from individual organisms of a species to multiple species systems requires an assessment of the variation occurring within and between species. This variation had to be experimentally measured and quantified. Other examples of ecological complexity are soil heterogeneity and the variation in concentrations of a substance to which the organism is exposed.

Part of the scientific work was conducted in the field, but most work was done in experimental settings with test species. Protocols were needed to standardise the experimental conditions, and this was one of the tasks set for the Netherlands Integrated Soil Research Programme (SPBO, see Chapter 4, episodes 1 and 2 for more background). Examples of experimental conditions that required standardisation are: duration of exposure, selection of test species, standardisation of soil used in experiments and food. In modelling multiple species systems, numerous assumptions had to be made to assess the effects of substances on such systems. Accordingly, different models were developed, each with different assumptions and different data input. The main models are discussed and their assumptions are explained. The labelling of usable knowledge in this case centred on the assumptions in these models used to determine the maximum tolerable level. The modelling consisted of two steps. First, the effects on a single species were modelled, and specific concentration levels were determined. Second, these concentration levels were used as input for multiple species models. In the following two sections these two steps are explained.

6.2.1 Single species dose-response relations

In the first step, data from single species toxicity tests are collected and modelled. In experiments, individuals of a test species (well known are springtails and earthworms) are exposed to soils, spiked with known concentrations of a certain substance. In a series of experiments, the animals are exposed to a range of concentrations in an experimental setup consisting of several replicates and controls. Exposure time is kept constant (i.e., standard exposure for earthworms is two weeks). Several endpoints can be measures, but mortality, growth and reproduction are mostly used. The measurements are related to the exposure concentrations and through regression analysis, a relation between concentrations and, for instance, survival is determined. The resulting models produce graphs like Figure 6.2 below.

On the X axis the logarithm of the concentration of a substance is plotted. The response is on the Y axis. The graph shows the relation between effect (for instance, mortality) and concentration under the specific exposure time and climatic conditions. The shape of the curve above is typical for xenobiotic substances, i.e., those substances that are not naturally occurring in the body. Essential substances are required in certain concentrations for essential processes. Concentrations of these substances that are below as well as above a certain level have an adverse effect. Dose-response

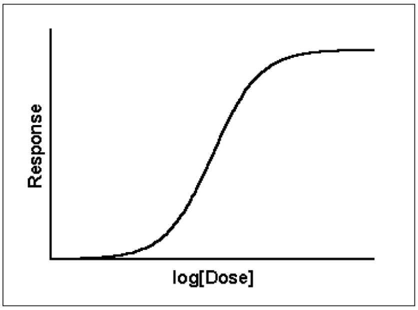


Figure 6.2 Concentration response curve, giving the relation between the concentration of a substance and response or effect. The organism is exposed to a specific concentration, but takes in only a fraction of that concentration. This dose (i.e., internal concentration of the substance causing the effect) is most accurate to use in these relations, but is experimentally difficult to determine. For this reason mostly concentration-response curves are drawn instead of dose-response curves.

relations for essential substances thus are typically bell shaped, and have an optimum range of concentrations. Drawing dose-response curves requires data derived from replicated experiments under controlled conditions in the laboratory. Given the variation in experimental data (for instance, due to individual variation between organisms) and the restricted number of data (due to practical delimitations) these curves are drawn using statistical extrapolation techniques. Analytical statistical techniques are applied to determine the Lowest-Observed-Adverse-Effect Level (LOAEL) or No-Observed-Adverse-Effect-Level (NOAEL). Due to experimental errors and natural variation between organisms, there is always a variation in the data, as indicated in Figure 6.3 by the vertical lines, which represent the standard deviation. The NOAEL is the highest dose on the X axis at which no significant deviation from the 0% response is observed. The LOAEL indicates the lowest level, significantly different from the control level, at which no adverse affects were observed.

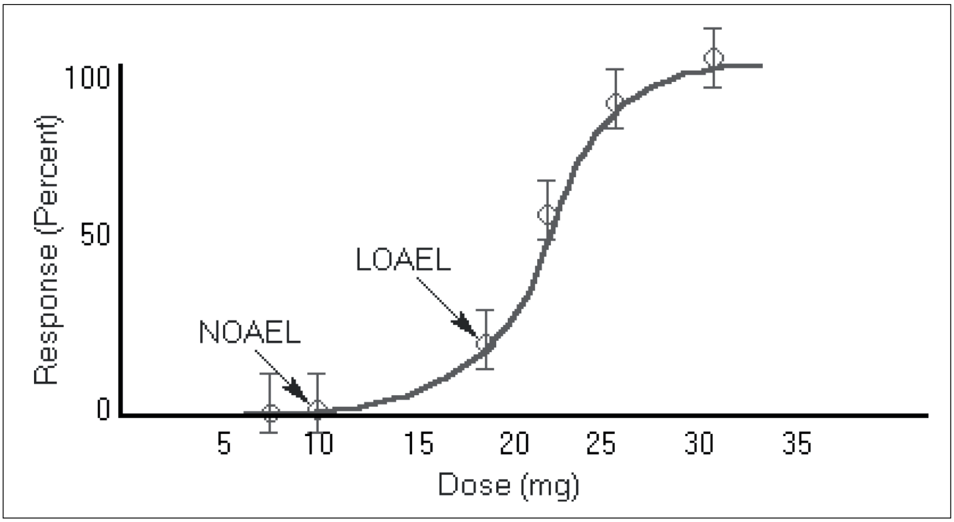


Figure 6.3 Typical dose response curve, with LOAEL and NOAEL as examples of characteristic dose levels. The vertical error bar of the LOAEL overlaps with the error bar of the NOAEL.

Through statistical operations two characteristic concentration levels can be determined from these single species dose-response relations: the EC50 level and the NOEC level. The EC50 level is the concentration level at which 50% response (or effect) occurs. The measured effects could be growth or mortality (these are most frequently used endpoints). In case mortality is the endpoint, the EC50 is expressed as LC50 (Lethal Concentration for 50% of the individual organisms). This concentration level (LC50) was used by Kooijman in his model, that will be discussed in more detail in Section 6.2.2. The second concentration level that can be calculated from these single species dose-response relations is the NOEC (No-Observed-Effect-Concentration), the highest concentration level at which no significant deviation from 0% effect occurred) for species occurred. The NOEC was used by Van Straalen in his model, that will also be discussed at more length in Section 6.2.2. The NOEC (like the EC50) is specific not only for species, substance and climatic conditions but also for exposure time. Clearly, chronic exposure to a concentration will eventually have more effects than a short (acute) exposure to the same concentration. Although it is generally acknowledged that chronic exposure is more realistic, experimental setups are designed preferably for acute toxicity tests. Statistical procedures have been developed to relate acute NOEC to chronic NOEC levels. After having calculated these chronic NOEC levels, NOECs are used to asses the effect of substances on sets of species in Species sensitivity distributions (SSDs). Initially, these models were called 'extrapolation models' In a review of these models (Posthuma et al. 2002), they were called 'species sensitivity distributions' (SSD). That name and acronym are used throughout this thesis.

6.2.2 Species sensitivity distributions

With the availability of datasets on single species dose-response relations, it was necessary to scale up from single-species to multiple-species systems. Given the complexity of these models they are first discussed in general terms. Subsequently, the specific differences of the two models are explained. The following description of the SSDs is taken from a recent publication (Posthuma et al. 2002) on the use and history of these models.

> An SSD is a statistical distribution describing the variation among a set of species in toxicity of a certain compound or mixture. The species set may be composed of a species from a specific taxon, a selected species assemblage, or a natural community.
>
> ...
>
> It may be assumed that by protecting most of the species with a conservative cut-off value, the associated percentile (concentration) is also protective of ecosystem properties, but that assumption remains to be validated.
>
> (Posthuma et al. 2002)

Species Sensitivity Distributions are constructed by plotting NOECs from the previous modelling step (after a log-logistic transformation) on the X axis. The number of species for each NOEC is plotted on the Y axis. Assuming a log-logistic normal distribution, a curve is plotted through these data.

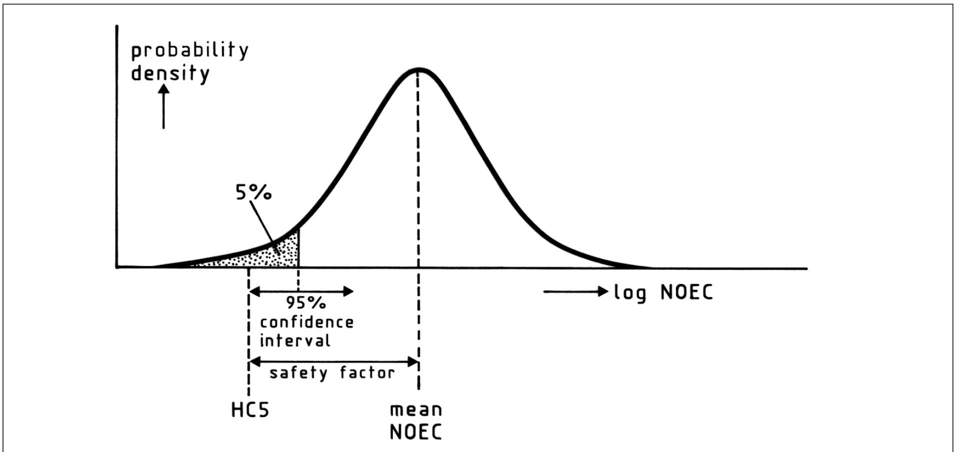


Figure 6.4 Typical species sensitivity distribution. The log NOECs from the tested species are on the X axis. The fraction of species with the corresponding NOEC level is on the Y axis. The mean of the distribution HC50 (or mean NOEC) is used to derive intervention values (Section 6.4.2). The HC5 is the lower level of the 95% confidence interval for the log concentration above which 95% of the species is exposed to lower levels than their NOEC. This HC5 is used to derive target values.

This curve is informative about the distribution of vulnerability of species to a specific substance. The left side of the curve represents the species that are vulnerable to the specific substance. The NOEC is the concentration level above which the species experiences an adverse effect. The lower this concentration, the more vulnerable the species is. At the other end of the distribution (on the right) are the tolerant species. They resist high concentration levels, before adverse effects are observed. Typical is the bell shape of the curve; there are only a few vulnerable and a few tolerant species. The largest fraction of the species is in the middle part of the distribution with an average vulnerability. The most vulnerable species, at the left of the distribution, are the species at risk of adverse effects of substances at low concentrations.

As explained earlier, the maximum tolerable level of a substance is defined as the concentration level above which 95% of the species do not experience an adverse effect. The height of this concentration level determines the height of the standard for this substance. SSDs propose patterns; algorithms for the sensitivity of sets of species to toxic substances. Besides an integrative function, these models also have a prescriptive, predictive function. Without conducting all possible experiments, (testing all potentially toxic substances on all species, on combinations of species, in a variety of concentrations and exposure time, measuring effects varying from mortality rate to population growth rate) these models conceal knowledge or assumptions about the expected effects of substances. Given the fundamental lack of data, assumptions about the toxic mechanisms and about the sensitivity of species or taxonomic groups are at the heart of these models. Describing the assumptions, making them as robust and trustworthy as possible, is one of the crucial aspects of a model. With all models, the assumptions in the SSDs are the Achilles heel. Now that there is a distribution of species sensitivity, the issue is where to set the level of acceptable risks. The answer is stunningly simple and in sharp contrast to all scientific calculations, extrapolations and modelling done so far. In fact, there was no solid scientific argumentation to set such a level.

> At that time I, I am a bit pragmatic… You have to answer the question in a different way. An answer that is not only fundamentally right, but it also has to be palatable; it has to produce a usable result. The only thing I could think of was that 5% fraction.
> (Interview quote, author of the Van Straalen method)

Having explained the general characteristics of these SSDs the alternative models that were developed, and evaluated by the Health Council, are explained. The two main models: Kooijman and Van Straalen, are explained with a focus on their differences. These models were evaluated by the Health Council in 1988[15] to be used to calculate the concentrations levels that served as input in the development of standards used in soil policy.

Kooijman (1987)

The first attempt to provide policy with an approach to assess the risks for ecosystems was te approach developed by Kooijman (1987). Kooijman was working as a theoretical ecologist at the Free University in Amsterdam when he published his model, but started work on this extrapolation model earlier while working at TNO in government-funded projects (Kooijman 1985a). Kooijman was concerned with the protection of the most sensitive species, more than with the protection of a fixed set of species (like 95%). Kooijman developed his model to deal with the enormous differences in sensitivity between species (Gezondheidsraad 1988). Kooijman was motivated to increase the awareness amongst researchers and policymakers that extrapolations beyond the limits of knowledge required the application of safety factors. Implicit in this motivation was his plea to fund more ecological research to increase the experimental database, and to provide more reliable estimates of concentration levels (Kooijman pers. comm).

15 In addition, models were developed by the Environmental Protection Agency (EPA 1984) and by Blanck (1984)

Kooijman developed an extrapolation model based on data from dose-response curves from laboratory experiments on aquatic species. His starting point was to use chronic LC50 values and derive from these a concentration level that would protect the sensitive species in a community. LC50 values were calculated in most single-species toxicity experiments and available in datasets. Kooijman calculated the (geometric) mean of LC50 values of tested species and divided these by a safety factor resulting in the Hazardous Concentration for Sensitive Species (HCS). [16]Preferably chronic exposure is used, but for practical reasons acute exposure is applied, and statistically translated into chronic LC50 values. This safety factor depended on the number of test species and increased with the size of the community (larger communities are more likely to include sensitive species, as assumed by Kooijman). It also depended on the variation in LC50 values, and on a coefficient determining the probability that the proposed safe concentration is larger than the LC50 of the most sensitive species. The HCS can be regarded as a lower boundary for concentrations that can be expected to be harmful for a given community. The HCS has been chosen so that the LC50 value of the most sensitive species in a community of a certain number of species exceeds that concentration by a specified probability (Kooijman 1987). Typical about this method is that the HCS depends on the number of test species and on the number of species in the community. Kooijman assumed that LC50 values of community species and test species have a log-logistic distribution. Kooijman did not select his test species for their ecological function, taxonomic group or other ecological criteria. He assumed that those characteristics were not determinant for the distribution of sensitivity, and therefore not important to consider. By the time he developed the first versions of his model no decisive research was available on this issue.

Van Straalen (1989)

Van Straalen and Denneman developed their method to be used in soil policy. Their model was explicitly developed for soil ecosystems and, in its original publication (Van Straalen and Denneman 1989), presented very much as a reaction to the model proposed by Kooijman. Compared to the model by Kooijman, Van Straalen used a log-logistic distribution of NOECs (where Kooijman used LC50 values). The authors argued that NOECs in comparison to LC50 values better represented field situations. Van Straalen and Denneman also argued that the test species should be selected on the basis of three ecologically relevant criteria: Firstly, the ecological functions; primary producers, consumers and saprotrophs (detritivores), should be represented. Secondly, the set of test species should include species exposed to chemicals through different exposure routes (from soil water, ingested soil material, and soil air). Thirdly, the test species should represent species with different anatomical design (taxonomic groups) as they were found to be different in sensitivity to toxic substances (Van Straalen and Denneman 1989). These ecological criteria were not applied by Kooijman; he doubted the ecological grounds for differences in sensitivity at the time. As a third contrast to the model by Kooijman, these authors chose not to calculate a hazardous concentration for the most sensitive species. They followed another line of reasoning. They calculated the HC*p*, the hazardous concentration for *p*% of the species, with *p* as a relatively small number. In their original publication the authors used a *p* value of 5. In other words, in the SSD in Figure 6.4 above they calculated the concentration level that corresponds with the 5% interval of the most vulnerable species. This approach produced different concentration levels indicative of the protection of a multiple species ecosystem. In most cases the model by Kooijman produced a lower Hazardous Concentration (HC) level (but one that depended on the number of test species and the number of species present in the community). Figure 6.4 below compares the two methods.

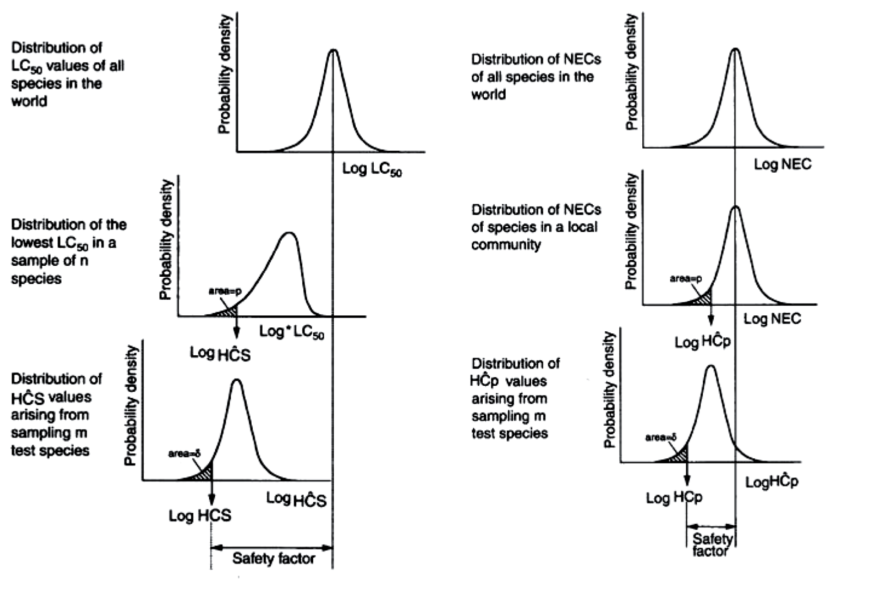


Figure 6.4 The difference between the HCS model (Kooijman) on the left, and the HC5 model (Van Straalen) on the right.

In this figure, the three distributions display the differences between the two models with respect to the statistical/mathematical choices. Internationally, the development of ecotoxicological experimentation also continued, notably in Denmark (Wagner and Løkke 1991) and the US (Blanck 1984; EPA 1984). The setup of experiments to develop dose-response relations within species as well as assessments of effects on ecosystems (multiple species and their interactions) were the focus of ecotoxicology as a scientific field in the 1980s and 1990s. In 1992, the approach applied in the Netherlands was approved by the OECD (1992) to serve as the European model (Van Straalen and Van Leeuwen 2000). The models differed in their selection of test species.

6.3 Labelling usable knowledge

The contours of an approach to model multiple species systems and calculate risk levels was sketched in 1985 as an appendix to the PTCSP"s advice on the reference values (discussed extensively in Chapter 5 (Denneman et al. 1985). Through the publication in this advice, part of the labelling of usable knowledge was done. By publishing the appendix, the PTCSP helped to launch this ecological approach in effect-oriented environmental policy, and, being a significant advisory committee to the ministry, its commitment was effective. The authors of the ecological approach in PTCSP's advice not only brought forward their knowledge and expertise on effects of substances and how to assess these, they also explicitly connected this expertise to a significant policy problem as illustrated by the quote in Section 6.2. The ecological approach was further refined and fleshed out through research projects under the flag of SPBO and the Project Integrated Standard Setting.

An important second step in the labelling of usable knowledge for the development of standards for soil quality was the Health Council's advice on the Ecotoxicological Risk Assessment of Substances (Gezondheidsraad 1988). In December 1987, the Minister of Housing, Spatial Planning and the Environment asked the Health Council to provide an advice on the extrapolation methods best suitable for risk assessment (and to be used in the Scoping Documents[16]). The Health Council was asked to evaluate a report prepared by an Interdepartmental Working Group on Risk Management of Ecosystems. It is important here to note that the Health Council is now actively involved in this second case, whereas its role was limited in the previous case study. The reason for this is that the Health Council had meanwhile expanded its scope, to include Environmental Health next to Public Health issues (see (Bal et al. 2002) for a description and analysis of the role of the Health Council in scientific advisory).

This working group proposed the minimal requirements for scientific data to be included in the Scoping Documents for substances. This proposal contained a differentiated procedure for risk assessment for different environmental compartments (water, air and soil). For soil, the working group proposed the following procedure:

16 A scoping document provides the basic information of a substance, including its toxicity and is used as input for the development of standards. It is prepared by the RIVM (also see Figure 1.3a).

> A minimal requirement are results of acute toxicity tests with plants, earthworms, and soil arthropods (according to OECD Testguidelines).
> In case LC50 /exposure concentration is > 100, values can be calculated applying the methods by Kooijman (1985, 198)7 and Van Straalen (1987).
> In case LC50 /exposure concentration is < 100, chronic tests need to be executed with the above-mentioned test species. With the results of these experiments, concentration levels need to be calculated with the above methods.
> (Werkgroep Risicomanagement Ecosystemen 1987)

The working group was not explicit in its choice for the models to be used by putting both models between brackets. The Minister of Housing, Spatial Planning and the Environment's request (December 29, 1987) contained the following:

> …an evaluation of the proposed procedure, an assessment of the protection level of ecosystems following this proposed procedure, its applicability and the gaps in the procedure.

The letter further invited the committee to propose directions to fill the gap and to bring in new approaches that existed but were not mentioned by the Working Group. In the letter it was made clear that the existence of other approaches should only be signaled, but should remain outside the evaluation. In other words, the committee should restrict its evaluation to the models mentioned in the proposed procedure by the Working Group (Gezondheidsraad 1988 pp.19-20). With this restriction, the letter explicitly labels usable knowledge by excluding alternative models from the advice. The models developed by EPA and by Blanck (mentioned above), were not to be included in the advice. Although I did not track the argumentation for this selection made by the Minister in his request for advice, it could be suggested that the selection of models exclusively from Dutch origin has been a strategic choice. The Minister can steer the development of such models in the Netherlands by allocating funds, but this is not so easily done internationally. In addition, as was shown in Chapter 4 (first episode) the creation of a coalition between science and policy was considered important. Clearly, it would be easier for the ministry to develop and maintain such a coalition with national, Dutch scientists than with an international scientific community.

The Health Council Committee, installed in January 1988 to write the advice, consisted of ecologists and ecotoxicologists. Amongst the members were the two authors of the extrapolation methods (Kooijman and Van Straalen). The committee took the freedom to give its own interpretation to its task and proceeded with drawing up an overview of the state of the art in ecotoxicology, thus evaluating the scientific quality of the proposed procedure. This assessment then was followed by an evaluation of the relation between the proposed procedure and Dutch policy for the protection of ecosystems. The first statement by the committee is that insufficient scientific knowledge is available on the structure and functions of ecosystems and consequently that further research must be carried out, fundamental as well as applied (Gezondheidsraad 1988 p 25}. Such statements are obligatory for such committees, it seems. However, they become a nuisance when these statements are not more precise about the ways to acquire such insight. The committee concludes that

> …the procedure to be assessed is meant to judge the effects of substances on ecosystems based on the current, limited ecotoxicological knowledge.
> (Gezondheidsraad 1988 p. 26)

and further:

> The committee states that a protective strategy, based on such a small theoretical basis (i.e., the relation between structure and the functioning of ecosystems) is on several points contestable.
> (Gezondheidsraad 1988 p. 26)

According to the committee, there was no sound scientific reason to contend that the procedure as proposed by the Working Group would produce concentration levels at which the ecosystem would indeed be protected. The scientific basis was considered to be too small. According to the committee, the procedure proposed by the Working Group reflected the current state of scientific knowledge. The committee then reformulated the request for advice:

1) The assumptions and applicability of the procedure, the prerequisites for experimental results, the selection of the extrapolation method.
2) The selection of test species and tests.
3) The extrapolation methods in the procedure, including a comparison with other available methods.

(Gezondheidsraad 1988 p. 27)

In doing so, the committee restricted the span of the advice to the scientific aspects of the proposed procedure. The committee wanted to refrain from the suggestion that it would qualify either of the models as appropriate (i.e. perform labelling of usable knowledge). In the advice the committee compared the two models. In this comparison, only scientific criteria (experimental conditions, choice of parameters, and the size of the sampled population) were included. Below are some examples to illustrate the scientific character of the comparison.

> The Kooijman model does not take into account the relations between species and is exclusively based on results from laboratory experiments. Under field conditions, the fraction of the substance that is available to species is lower.
> (Gezondheidsraad 1988 p.37)

> The assumption in the Van Straalen method that an ecosystem is protected if only 5% of the species is exposed to concentrations above their NOAEL [See Section 6.2.1 for an explanation of this term, AS] is not scientifically grounded.
> (Gezondheidsraad p. 39)

> The assumption of a log-logistic distribution in both models is contestable. The results from the Van Straalen method are less determined by the shape of the distribution at the upper and lower end of the distribution.
> (Gezondheidsraad p. 39)

So far, the committee concludes, there were no scientific grounds to prioritise one method over the other. In search for grounds to distinguish between the methods, the committee broke down the methods to two basic aspects: the *principle* of the methods and the *approach* of the methods, and investigated whether these two aspects could provide grounds for differentiation or not. The principle of the method by Van Straalen was considered problematic if a combination of substances had to be evaluated. The committee argued that it is most likely that for each substance a different 5% of the species is exposed above their NOAEL, whereas in the Kooijman model the chances of the most sensitive species being exposed to a concentration per substance can be calculated. A second difference was that the method by Kooijman always produced lower concentration levels (i.e., it is more strict). The outcome of this analysis by the committee did not alter the previous conclusion: both models cannot pretend to produce concentration levels that protect the ecosystem.

In its advice, the committee proceeded the investigation by applying datasets for two substances (Cd and γ-HCH) to both methods and compared the outcomes and reached two conclusions: Firstly, the outcome produced with the model by Kooijman depends significantly on the size and quality (in terms of the variation between the LC50s or NOECS values) of the available dataset. This variation could produce differences up to a factor 10 in the resulting HCS. The fact that experimental conditions caused such variation in the outcome of the model was counter to the principle that the outcome of extrapolation methods would depend mainly on the variation between species, the committee concluded. The calculated concentrations by the Kooijman method were determined to a large extent by experimental differences, rather than by actual differences between species. Secondly, the outcome of the Van Straalen method produced concentration levels that resembled the concentrations calculated from available NOEC data from a large dataset on aquatic NOECs. In other words, the outcomes of the Van Straalen method were supported by empirical data. This validation of the Van Staalen method was deemed important by the committee. This was used by the committee as a reason to prefer the Van Straalen method.

In this part of the advice the committee evaluated both models on scientific grounds. However, the first point (i.e. that the outcomes produced by the Kooijman method were contingent with experimental conditions) is related to the applicability of the method and not to scientific criteria in the strict sense. The problem lies not in the model itself – Kooijman had always made clear that the parameters in the model were sensitive to experimental conditions. The problem was rather in the applicability, or robustness of the model. Indeed, with new and better experimental conditions, the outcome of the model would be different, implying that with new and better experimental conditions, the calculated concentration levels would become less strict. Clearly, such an outcome is difficult to maintain in policy: more and better experiments can result in less stringent risk levels. This part of the advice exposed the criteria applied by the committee in assessing the different extrapolation models. In the next part of the advice, the committee analysed the proposed method developed by the Working Group Risk Management Ecosystems. On pp. 68-69 of the advice the committee writes:

> The procedure does not explicate what model [Kooijman or Van Straalen] should be used, and what the status is of the calculated concentration levels. The different steps taken to extrapolate laboratory to field conditions should be described in more detail, especially as the two models differ with respect to this.
> (Gezondheidsraad pp. 68-69)

The committee then proposed to combine the Kooijman and Van Straalen method.

> 1) The HCS (Kooijman method) is calculated, based on acute toxicity tests with three standardised tests with δ1 and δ_2 at 0.1.[17]. In case bioavailability is known and the laboratory conditions are known to be very different from field conditions, the outcome of the Kooijman extrapolation (HCS) can be adjusted to U_k[18]
>
> 2) In case U_k is below the expected exposure concentration, chronic toxicity data are needed (see step 3). If not U_k is the outcome of the procedure, otherwise step 3 applies.
>
> 3) Based on chronic toxicity experiments conducted with ecologically representative test species, with δ1 and δ_2 at 0.05. [19], the Van Straalen method is applied. Also in case lab conditions differ from field conditions, the outcome is adjusted, resulting in U_{st}[20]. If the ecosystem contained species with a special value (economically, commercially, recreational), the U_{st} had to be adjusted so that it equalled the NOAEL of the most sensitive of these species.

17 δ_1 and δ_2 together determine the probability that the LC50 of the most sensitive species is below the HCS.

18 U_k refers to **U**itkomst **K**ooijman (outcome by Kooijman).

19 See fn. 17

20 U_{st} refers to **U**itkomst Van **St**raalen (outcome by Van Straalen).

4) The outcome of step 3 needs to be tested for other substances with available datasets.[21]
(Gezondheidsraad pp. 93-94)

A careful reading of this alternative procedure makes it clear that in most cases the Van Straalen method has to be applied. After all, the calculated U_k is known to be strict (see the description of the principles and approaches of the methods in Section 6.2.2). On p. 71 of the advice, the committee advises to set $?_1$ and $?_2$ in the Kooijman model at 0.1 at maximum, as otherwise the alternative procedure proposed by the committee would always result in applying the third step.

Although the Health Council proposed this alternative, with a prime role for the Kooijman model, the ministry used the model by Van Straalen to define the Maximum Tolerable Level (see the definition at the first page of this chapter). Consequently, the National Institute of Public Health and the Environment; the RIVM followed this definition of the risk approach and applied the Van Straalen method (Van de Meent et al. 1990) to calculate the MTL and NRL. At the RIVM, a number of modifications to the Van Straalen method were proposed.

Labelling knowledge in this second case draws the line between research science and regulatory science. The Kooijman method is a good example of 'research science' as meant by Jasanoff (1990). This claim is grounded on two observations. First, the Kooijman model grants a special status to the most sensitive species, that is, the most sensitive species being crucial to the protection of an ecosystem. According to Kooijman, the chances of the most sensitive species to be exposed above their LC50 must be of a specific small value. The Van Straalen model states that concentration levels can be estimated such that at most 5% of the species in a community is exposed above its NOEC. This has been interpreted usually as a concentration level that protects 95% of the species (in the sense that these species are not exposed to concentration levels above their NOEC), assuming that that might suffice as a guarantee of protecting the functioning of the ecosystem. The presentation of the Van Straalen method can be more readily connected to soil policy objectives. Second, this claim is grounded on the observation that the aims or motivations of the scientists with respect to policy differed. This difference was observed during the interviews for this research, but can also be found in the scientific publications. These explicate the motivations of the researchers for their work. The author of the Kooijman method attached greater value to recognition from the scientific community; recognition from policy was subordinate. The first author of the

21 This deviates from the text in the advice. In the advice, a third model is included. This is an extrapolation method by Slooff (1987) who worked at THE RIVM. In short, the essence of his method was to apply regression analysis to the available data. Slooff exclusively used aquatic data. Given this fact, together with the relative lack of ecological theorising behind the model, the HC committee criticised this approach, but nevertheless included it as a test for the outcome of the third step.

Van Straalen model tried to match scientific recognition and recognition from policy. The observed differences between the two models and approaches are typical for the distinction between research science and regulatory science and pertain to the relation between science and policy.

6.4 Setting the standards

Section 6.3 explained the production and labelling of knowledge applied in setting standards for soil quality according to the risk approach. The risk approach as such distinguished two risk levels (The Maximum Tolerable Level (MTL) and the Negligible Risk Level (NRL) at 1% of the MTL). The use of two risk levels originated from adjacent policy fields (policy on radiation, large technical installations and new substances to be put on the market). In environmental policy the approach was adopted as part of a strategy to harmonise policy fields concerning environmental threats. The exact wording of the risk levels was given in the above definition and as Section 6.3 showed, these were based on the scientific extrapolation model developed by Van Straalen.

Besides this (new) framework of risk levels introduced by the risk approach, the frameworks of ABC values and reference values (Chapter 5) were still used in soil policy. The scheduled evaluation of the ABC values (a requirement of the legal framework) provided an opportunity to integrate the existing standards in the new formulations of soil quality standards and risk levels. The new framework was published in full in the policy document MILBOWA. The relation between the existing and the new framework is as follows: the reference values derived in the previous episode are updates of the A values. With the introduction of the risk approach two 'new' standards were introduced: target and intervention values. Target values for substances demarcate clean soil from polluted soil. Target values are the policy formulation of scientifically derived Negligible Risk Level (NRL). For the Maximum Tolerable Level (MT), the scientific calculation and modelling was done by the RIVM and was published in a set of studies that were brought together in the report Desire for Levels (Van de Meent 1990). The target values thus are set at 1% of the concentration at which 95% of the species are exposed to concentrations below their NOEC (i.e. the MTL).

6.4.1 Target values

The development of target values as the operationalisation of the risk approach resulted in a complex statistical exercise, with still innumerable uncertainties (e.g., bioaccumulation, foodweb structures, exposure, aging, mixture toxicity (Van de

Meent, 1990)). It was decided that the target values should never be stricter than the background values (Van de Meent et al. 1990). In case the calculations would result in concentration levels below the background values, the target values would be set at these background values. For all metals, the calculations indeed resulted in concentration levels below the background values, and consequently the target values were set at these background values. The outcome of the statistical exercise and the subsequent policy considerations is therefore quite stunning; the target values are exactly the same as the reference values published in 1988 that were regarded to represent naturally occurring background concentrations (background values).

Table 6.2 Target values (Min.VROM 1991)

	Target values Concentrations in mg/kg dry soil
Cr	100
Ni	35
Cu	36
Zn	140
Cd	0.8
Hg	0.3
Pb	85
As	29

6.4.2 Intervention values

The intervention values were developed within the framework of the evaluation of the C values given in the Interim Act Soil Pollution (see Chapter 4). The evaluation of the C values would have to result in effect-oriented and scientifically underpinned standards. The C values, in the new terminology the intervention values, indicate that soil quality is such that treatment is necessary. Locations where concentration levels exceed the intervention values are classified as severely polluted which implies that they have to be further investigated to determine the urgency and the time schedule for treatment. The height of the intervention values directly determines the size and number of polluted areas that have to be cleaned in the near future.

The ecotoxicological component of the intervention values represents the concentration at which 50% of the species in an ecosystem is affected, i.e. the median value of the species sensitivity distribution or HC50. The scientific underpinning for this median value is contested and not explicated. In addition to the calculation of ecotoxicological effects, human toxicological effects are calculated[22]. The intervention value is set at the most critical of the two. The results of the ecotoxicological calculation of HC50 for metals are given in Table 6.3. The third column lists the intervention values (resulting from the comparison between ecotoxicological and human toxicological assessments).

Table 6.3 Ecotoxicological HC50 levels and intervention values. The intervention values are based on the comparison of human toxicological and ecotoxicological assessment. In the last column the C values are listed for comparison.

	HC50 mg/kg dry soil (Denneman and Van Gestel 1990)	**Intervention values** mg/kg dry soil (Min.VROM 1994)	**C values** mg/kg dry soil Interim Soil Pollution Act (Min.VROM 1982)
Cr	230	380	800
Ni	210	210	500
Cu	190	190	500
Zn	720	720	3000
Cd	12	12	20
Hg	10	10	10
Pb	290	530	600
As	25	55	50

6.5 From Case to Context

In the previous sections the scientific extrapolation models and the labelling of usable knowledge are described. This labelling not only facilitated the calculation of standards, but had a much broader meaning that is elaborated in this section, in which various impacts of this case on the context for standard setting and soil quality policy are explained. Most notably, the target and intervention values were operationalisations of the risk approach.

22 This thesis only addresses the ecotoxicological component of the intervention values. There was a separate track to assess the effects of substances on human health. The intervention value was set at the lowest of these two figures. See also: Health Council. 1995. The project Setting Integrated Environmental Quality Objectives. The Hague: Health Council of the Netherlands.

6.5.1 Giving meaning to the risk approach

In the National Environmental Policy Plan in 1989, the policy document 'Premises for Risk Management' was published. In this document the risk approach was outlined. Risk had been defined there as:

> Unwanted effects of certain activities and the probability that these effects occur. (Min.VROM 1989b)

In the document six aims of introducing the risk approach were listed and two of these are relevant for this thesis. First, the aim of **prioritising.** By introducing risk levels, priorities could be assigned. Intervention values became the tools to determine the urgency of locations that have to be treated. The issue of prioritising was important in soil treatment around that time. During the development of the intervention values, the Welschen Working Group evaluated the progress of the cleanup operation of the sites that had been designated as being polluted. This committee's report was discussed in Chapter 4 (Werkgroep Bodemsanering 1993). Priority setting of treatment of polluted sites was supposed to be an adequate answer to the recognised stagnation of the soil treatment operation, and was mentioned in the report of the working group as an important step forward. Second, the aim of developing a consistent set of standards with which it is possible to harmonise standards between the three environmental compartments, soil water and air. Or, in other words, environmental quality for all three compartments had to be in harmony. The extrapolation models were evaluated for this aim in the Health Council advice of 1988. For scientists this aim of the risk approach enabled the development of intercompartmental harmonisation models. The extrapolation methods or SSDs became tools to harmonise policy fields next to the assessment of potential risks to soil ecosystems.

6.5.2 Recreating meaning of multifunctionality

The concept of multifunctionality as developed in the first episode distinguished between different functions of soil. This differentiation of functions was used and interpreted in this case. Taking multifunctionality as the starting point, protection of the most vulnerable function was considered crucial. Taking legitimacy from the Soil Protection Act, the ecological function was considered the most vulnerable and became the focus of ecotoxicological models underpinning the target and intervention values. The ecological function, as a derivative of multifunctional soil quality became the focus of research programmes into the effects of substances on soil. Now that the scientific basis for standards for soil quality had been laid, the operationalisation of multifunctionality was started. It was no longer assumed, like it was in the first case study, that the ecological function was not adversely affected in relatively undisturbed areas. In this second episode the ecological function was more thoroughly researched. However, all significant policy and scientific documents in this second case study state that the knowledge available or developed by that time was insufficient, but there was agreement that significant steps were being made towards gaining insight in the ecological function and structure of ecosystems in this episode. This is an important difference with the previous episode. However, although this ecological function was further fleshed out with the development of the extrapolation methods, the principle of multifunctionality became subordinate to the risk approach as a guiding principle in soil policy. Central to the risk approach was the recognition of adverse effects, and this was counter to the concept of multifunctionality. As I described in Chapter 4, in the second episode, critical evaluations of the concept of multifunctionality and of the stagnation of the treatment operation coincided with the introduction of the risk approach. The immediate operationalisation of the risk approach in two Risk Levels and the quantitative operationalisation of 95% protection level contrasted sharply with the relatively loose and vague formulation of the principle of multifunctionality.

6.5.3 Giving meaning to effect-oriented environmental policy

The development of the Species Sensitivity Distribution was an attempt to construct a scientific valid concept for effect-oriented standard setting. This construct contained three contestable assumptions. The first assumption is that the ecological function of soil is the most vulnerable. The relation between ecosystem functioning and structure was elaborated in a seminal book by Odum (1971), who stated that an ecosystem is characterised by its relation between function and structure. The second assumption is that the structure of ecosystems determines the functioning of ecosystems. This assumption creates a hierarchy between structure and function. Formulated in line with the terminology of the policy documents on soil protection, the rationale behind the species sensitivity distribution is as follows: There is no serious risk for the functioning of ecosystems if the structure is not seriously affected. The third assumption that is probably the most contested is that whenever 95% of species composition is not adversely affected; there is no serious risk to the structure of the ecosystem. That is the meaning given to effect-oriented environmental policy through the labelling of usable knowledge as described in this case study.

In addition, effect-oriented soil policy in this second episode was dominated by effects on soil fauna. Plants were out of sight completely, as well as bacteria and fungi. A personal comment by Van Straalen suggested that the composition of scientists in the TCSP played a role; soil microbiologists were not playing a very active and concerned role, whereas botanical expertise was absent. In the discussions about the research programme SPBO (see Chapter 4, episodes 1 and 2 for an explanation of the programme), plant sciences were excluded explicitly, as that would increase the number of participants and consequently would fragment the available resources for research. These issues, the selection of members in scientific and policy-related committees concerning regulatory policy and the arguments used in those selection processes would be interesting to study, as already suggested in Chapter 3.

The joint introduction of a new policy concept (the risk approach) and its operational measures of target and intervention values is interpreted in this chapter as a successful and effective strategy to institutionalise the effect orientation in soil policy. Target values are the operationalised expression of the principle of multifunctionality, but above all they are instruments to implement the risk approach. Target values are problem setting in the sense that they make visible the size of soil pollution. In addition, target values are the goals of treating polluted soils. Cleanup has to result in soils that meet the target values, and reduce the area of polluted soil. Intervention values are a different type of standard. They are task setting. Below the intervention values, the so-called obligation to make an effort (inspanningsverplichting) should be respected. This obligation to make an effort is a normative rule to maintain the level of pollution and prevent its further increase. Concentrations above the intervention values have to be treated.

6.5.4 Demarcating regulatory science from research science

In the publication of their model, the authors of the Van Straalen method explicitly stated their interest to interact with policy. The abstract of the paper refers explicitly to the implementation of soil policy, and towards the end of their paper the authors evaluate the reference values for cadmium and state that the reference values as determined by the government were in need of adjustment (at least for cadmium). The authors further suggest presenting their work in a format such that policymakers would have to decide themselves about an adequate risk level (Van Straalen and Denneman 1989 p. 250). Kooijman is explicit about his ambitions in his paper. With the Health Council's advice, an important step was taken towards the development of the two risk levels announced in Premises for Risk Management in 1989; the Maximum Tolerable Level and the Negligible Risk Level. In Section 6.3 the differences between the two methods in this respect were explained.

6.5.5 Classification of soil

As explained in Chapters 1 and 3, standards have a performative role; standards classify (Bowker and Star 2000) and standards harmonise (Porter 1995).

> Target values indicate the soil quality where the risk of adverse effects for ecosystems and functions of soil is negligible.
> (Min.VROM 1991)

In a performative role, target values classify soils as either clean or polluted. Target values are expressed as concentrations of substances that are indicative of a specified environmental quality. Intervention values distinguish two subclasses within polluted soil. Above the intervention values soil is severely polluted and has to be treated. Below the intervention values the pollution is not severe. Further pollution has to be prevented, but there is no need for a scheduled cleanup. Target and intervention values classify soil into three categories: 'Clean', 'Not severely polluted soil', and 'Severely polluted soil'. Compared to the previous case, the classification has become more complex in two respects. Firstly, polluted soil has been subdivided into severely and not severely polluted soil. Secondly, rules of inference have become much more explicit and articulated. The standards are not only informative about the physical properties of the soil, but are also informative about the treatment schedule. The standards are much more performative compared to the previous case with respect to the treatment of sites.

In addition, the classification of soil has changed, although the concentration levels of target values and reference values are the same. If we look at Figure 6.5, the demarcation between clean and polluted is the same as the demarcation between clean and polluted in the previous case, study, but the meaning of the demarcation is different. In the previous case, the difference was that soil did or did not have the capacity to fulfill the ecological function, whereas in this case, the difference between clean and polluted is that soil quality is such that 95% of the species in the soil ecosystem are not exposed to concentration levels above their NOEC (with a safety factor of 100 applied).

This second case has produced a scientific method and a new approach (risk approach). Although the concentration levels distinguishing clean from polluted have not changed (the target values are exactly the same as the reference values) the definitions of these categories have changed, as they now refer to the protection of fractions of species. What complicates the understanding of the resulting classification is that in case the calculated target values are below the background levels as calculated in the previous episode, these latter values are used as target values. Upon doing so, the problematic aspects of the reference values; the fact that the substance specific formulas developed to calculate the reference values included only two soil characteristics (lutum and organic matter) and could not be used to differentiate between natural occurrence of substances and anthropogenic enrichment, remained.

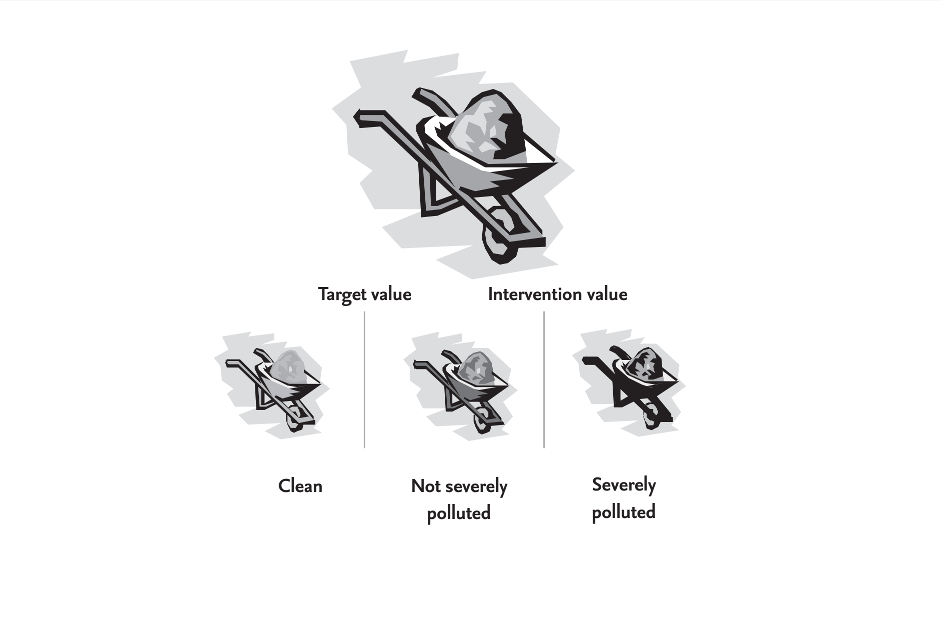


Figure 6.5 Based on the concentration of substances, soil is classified either as clean or polluted. Target values distinguish clean from polluted. Polluted soil is further classified into: severely and not severely polluted soil. Intervention values distinguish severely from not severely polluted soil.

6.6 Conclusions

In Chapter 3, research questions 2 and 3 were formulated for the case studies.

2. What knowledge is labelled as usable knowledge?
3. What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context?

In this section the research questions are answered for the second case study. The (disciplinary) background of knowledge that is labelled as usable is described. Also the relation between the arguments applied in labelling and the institutional context is given.

Related to this second case study, research question 2 (What knowledge is labelled as usable knowledge?) could be answered as follows. The scientific knowledge that is labelled as usable in this case study is experimental ecotoxicological knowledge, mainly conducted on soil fauna. Besides the single species dose-response experiments, the development of extrapolation methods has been boosted through the labelling process. Compared to the previous case, the importance of ecological research relative to soil science has increased enormously. The disciplinary origin of the knowledge labelled as usable is clearly different from the first case. There is a second important conclusion to draw with respect to the type of knowledge: the discussions about the risk apporaoch and the species sensitivity distributions revealed a demarcation between regulatory science and research science. Regulatory science has been labelled as usable.

Related to this second case study, research question 3 (What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context?) could be answered as follows. As stated in the report by the Health Council, the arguments in the labelling process concerned scientific aspects of the compared methods. The Health Council tried to differentiate between the two methods and phrased its argumentation in scientific terms (choice of parameters, species selection, scientific methods), as pointed out in Section 6.3. In the alternative procedure proposed by the Health Council, the two methods were combined. In practice the Van Straalen method was applied (after some modifications) by the RIVM to calculate the concentration levels and to derive target and intervention values. The arguments in the labelling process concerned the operationalisation of the risk approach, and these arguments were related to the cognitive dimension of the institutional context. As pointed out in the first section of this chapter and in Chapter 4, the cognitive dimension in this episode was characterised by the introduction and development of the risk approach. In part, the arguments for labelling were related to the normative dimension. During the second episode the interaction between science and policy intensified. The increasing number of involved actors, the harmonisation of environmental quality standards and criticism on the principle of multifunctionality was reflected in the closer relation between science and policy. It could be argued that the motivation of the authors of the Van Straalen method to contribute to, and further the development of policy played a role in the labelling of usable knowledge in the Health Council report. It could be claimed that regulatory science was valued over research science in the development of soil quality standards in this second case study. Compared to the previous case study in which the reference values were developed, the argumentation here did not refer to the regulative framework. The integration of the Interim Soil Pollution Act did not explicitly provide arguments in the labelling process. The normative dimension, mainly characterised by the increasing number of involved actors, did not play a decisive role in the labelling process in this case either. As we will see, this dimension became much more important in the third case study, when the soil remediation objectives were developed.

CHAPTER 7

Soil remediation objectives

In Chapter 6, the development of standards for effect-oriented policy, based on the principle of multifunctionality and the risk approach, was described. The implementation of these standards caused problems entailing hold-ups in other activities like building and construction. These problems, together with the huge financial costs of treatment according to the principle of multifunctionality, gave rise to numerous critical reports and evaluations. These have been discussed in Chapter 4. As described in that chapter this criticism led to the policy renewal BEVER. Within the context of BEVER, a new framework for standards, as objectives for treatment were developed. Most prominent in the policy renewal was the change from multifunctionality as the guiding policy principle to function-oriented remediation of immobile pollution and the reorganisation of the process to establish remediation objectives. BEVER aimed to restructure both the content of the policy as well as the process. Within that complex institutional context, usable knowledge had to be labelled to formulate the soil remediation objectives (SROs). The labelling process and its outcome are the subject of this chapter.

As the framework of soil quality standards was further detailed by the introduction of the soil remediation objectives (SROs) it is important to keep in mind the differences between the SROs and the target- and intervention values. The intervention values were not replaced. They were and still are used to identify severe soil pollution The SROs are targets for remediation and they are used as standards for the quality of topsoil layers. The SROs are remediation objectives in a function-based soil policy, while target values were the remediation objectives in soil policy based on the principle of multifunctionality. That principle still applied to pollution originating after 1987 (the year in which the Soil Protection Act was implemented). In sum, the SROs pertain to the quality of the topsoil after the treatment of severe soil pollution originating from before 1987. Until the function-based approach was officially adopted in June 1997, standards for soil quality were contingent on human health and ecosystem health and applied to soil irrespective of the actual or future land use. This was changed by the formulation of the soil remediation objectives within the framework of BEVER. Soil quality now became contingent on land use. Provinces and municipalities now were more explicitly involved in the development of these new standards. This change was brought about by the criticism on soil policy and soil quality standards that had arisen in the years before (see Chapter 4 for an explanation). The policy renewal included the development of new standards. In this case study the analysis is restricted to the labelling of usable knowledge for the development of soil remediation objectives for immobile pollution.

Demarcation of the case

The development of new standards was part of the policy renewal project BEVER. As explained in Chapter 4, BEVER consisted of a number of projects of which the 'remediation goal appraisal process' was the one containing the development of new standards. The BEVER project ('Track A') started in 1997 as the follow-up from the Cabinet's position in June 1997 (see Chapter 4, episode 3 for an explanation of the Cabinet's position). Track A was coordinated by 'Core team A'. The start of Track A demarcates the beginning of the case. In 1999 the results of 'Track A', were the soil remediation objectives (SROs). In Dutch the new standards are actually called *bodemgebruikswaarden.* A direct translation would be: soil-use values. However, the official English translation as given in the report From Funnel to Sieve is: soil remediation objectives. The English translation puts the standard forth as the objective for remediation, but the meaning in Dutch policy is different. SROs are also quality standards for the topsoil. In case topsoil is removed and replaced by soil from elsewhere, this 'new' topsoil has to meet the SROs. The official translation is used in this thesis, but the reader should be aware of the meaning of SROs in Dutch soil policy. SROs are standards for minimal soil quality for specific land-use types expressed as concentrations of substances. These SROs concern the *quality* of the topsoil. Also the thickness of the topsoil layer to which these SROs applied was defined.

In the development of the SROs, two stages can be discerned. In the first stage, from June 1997 until May 1998, all efforts led to the identification of seven land-use types with a list of user criteria per land-use type and a set of minimum soil quality criteria. The second stage lasted until June 1999 and was a revision of the first stage in the sense that the number of land-use types was reduced to four. This reduction required reconsideration of the specifications per land-use type, the user criteria and the minimum soil quality criteria. Section 7.3 will explain the terms 'land-use types', 'user criteria' and 'minimal soil quality criteria' in detail. The SROs were published in 1999 and this publication demarcates the end of the case.

Where the previous case studies were concerned with further operationalisation or modification, this third case study is about a drastic change of policy. In the process of policy change and development of new instruments, several instances of labelling usable knowledge could be observed. The analysis here is restricted to two instances. First, the classification of land-use types is analysed. The reasons for reducing the seven land-use types to four will be pointed out. Second, the labelling of knowledge to developed SROs per land-use type is analysed in this chapter.

Two other issues that might have lent themselves for an analysis of labelling processes concern the decision about the thickness of the topsoil layer to which these SROs applied. A second and related issue is the distinction between mobile an immobile pollution. The distinction between mobile and immobile became important; mobile pollution can diffuse from one land-use type (with its specific quality criteria) to the other land-use type where different quality criteria applied. When the analysis described in this chapter was conducted both issues had not yet been resolved. In sum, the labelling of usable knowledge for the classification of land-use types and the corresponding SROs are analysed in this case study. The other two issues are explained briefly in the second half of Section 7.2

7.1 From context to case

In 1995, the renewal of soil policy started. This policy renewal was the long-awaited response to several critical reports from the past years on the actual course of soil policy. The criticism was explicitly reported for the first time in 1993, by the Werkgroep Bodemsanering (Werkgroep Bodemsanering 1993), In this report, the principle of multifunctionality as an underlying concept for policy and standards was criticised, but supported as well. A few years later, in 1996, an interdepartmental policy analysis concluded that the pace of the treatment was too low (Min.VROM 1997) and caused stagnation in land use dynamics. According to this analysis, the stagnation was caused by the high costs of treatment (related to the high standards) and the long and complex administrative processes preceding actual treatment. A second, related, criticism focused on the process of deriving standards and the representation of stakeholders (BEVER werkgroep 1997). The policy renewal was organised as an open policy process named: BEVER, a Dutch acronym referring to the beaver. The metaphor was used to point out that BEVER had to re-establish connections and to build dams between the several policy fields and involved stakeholders. BEVER provided the context for the development of new standards. The policy renewal was framed by six aspects published in the Target Perspective (Alons & Partners 1996):

1 *From sectoral to integrated*
2 *From multifunctionality to function-based*
3 *From project to process*
4 *From central to de-central*
5 *From government to market dynamics*
6 *From setting standards (values) to sharing standards (values)*

Central to the renewal was to bring about a shift from 'multifunctionality, unless…' into a function-based perspective on soil quality. In June 1997, the Cabinet's position laid down the new course for soil policy and announced new standards. The development of these standards, the SROs, was organised as an appraisal process. Chapter 4 discussed this episode in detail and concluded with a summary along three dimensions that is repeated here.

Table 7.1 The three dimensions of the institutional context in the third episode as described in Chapter 4. Critical events, achievements and developments are given for each dimension.

Regulative	• Revision Soil Protection Act (1994)
	• Cabinet's position (1997)
	• Building Materials Decree (1999)
Cognitive	• Function-based quality
	• Risk approach
	• Multifunctionality
Normative	• Active soil management
	• Soil policy renewal: BEVER, six aspects from Target Perspective
	• Soil research programmes (PGBO, NOBIS, SKB)

7.2 Remediation goal appraisal; issues to be resolved

In the Cabinet's position in June 1997 the change from 'fit for multifunctionality, unless…' into an assessment of 'function-based quality' was announced. One of the issues that had to be addressed in operationalising the new soil policy was the development of function-based soil quality standards. In the course of the project these standards would also have to serve as objectives for the remediation of polluted sites. The development of an appraisal process to establish remediation objectives became the subject of Track A, coordinated by Core team A. This Core team, that consisted of representatives from the Ministry of Public Housing, Spatial Planning and the Environment, the Association of the Provinces of the Netherlands (IPO), the Association of Netherlands Municipalities (VNG), Small and Medium Enterprises (MKB) and the Confederation of Netherlands Industry and Employers (VNO-NCW), had five tasks to accomplish with regard to the policy renewal:

1 *Distinguishing mobile from immobile pollution,*
2 *Distinguishing topsoil from subsoil,*
3 *Establishing land-use types,*
4 *Differentiating between standard and customised approaches for treatment,*
5 *Differentiating between customised approach per area and per case.*

The first three issues are related to the development of remediation goals. Of these, the first two are discussed briefly in this section. The third issue (establishing land-use types) is analysed in depth in this chapter. The fourth and fifth issue fall beyond the scope of this thesis and are therefore not further addressed.

Once the function-oriented approach was adopted, the first issue to be resolved was the distinction between mobile and immobile pollution. This was a difficult but crucial issue, as it determined the options for treatment of substances and soils. It is important to differentiate between mobile and immobile pollution in a function-oriented approach since mobile pollution can diffuse between areas with different land uses where different functions of soil are to be protected. Differentiation is also important because of threats to the quality of the groundwater. Hence, a clear definition of what is meant by mobile and immobile pollution was required. As the scientific grounds for a distinction were too complex, the National Institute for Public Health and the Environment (the RIVM) proposed a pragmatic approach and distinguished between 'evidently mobile' and 'evidently immobile' and a third group consisting of situations that are neither. After measurements of concentrations in the groundwater and assessments of actual diffusion the pollution is classified as mobile or immobile. The deciding factor is the measured concentration in the groundwater exceeding a specific standard (the RIVM proposed to use the intervention values for this purpose) (Lijzen et al. 1999a). This approach was adopted by Core team A. It was criticised by TCSP as it would introduce implementation problems. These problems would occur because of the relation between soil pollution and earth streams[23] policy (TCB 1998; Van de Haar 1999). Therefore, TCSP suggested applying a case-wise approach and refraining from a generic approach. In its advice TCSP argued not to develop a generic approach based on scientific knowledge until the implementation practice asked for such generic approach to distinguish between mobile and immobile pollution. The criteria to distinguish between mobile an immobile were not yet ready by the time the analysis of the empirical material for this case study was finished. In Core team A's final publication in 1999, the distinction between mobile and immobile and the remediation objectives for mobile pollution were addressed as important issues to be resolved.

1 Grondstromenbeleid.

Immobile contamination and mobile contamination

Lesson in soil chemistry

The mobility of a contaminating substance in the soil depends on the characteristics of the substance and those of the soil. Thus, a chemical complex like BTEX in one soil may be immobile and therefore only occur in the topsoil, and in another soil it may be mobile and thereby occur mainly in the groundwater. This is connected with, amongst other things, the degree of acidity and absorbing capacity of the soil.

Definition

If we speak about an immobile contamination or a mobile contamination, we always allude to a specific substance in a specific soil. It is therefore always a matter of specific situations.

Immobile contamination

A situation in which substances do not dissolve or dissolve poorly in water and do not evaporate. These substances cannot spread or at least not readily and thereby often occur in the topsoil. Direct contact can lead to exposure

Mobile contamination

A situation in which substances dissolve well in water. The substance penetrates the soil with rainwater and can spread with the groundwater. These substances therefore usually occur in the subsoil.

Volatile contamination

A situation in which substances dissolve well in water and evaporate easily. The substances can then spread via the groundwater into the topsoil again.

(BEVER regiegroep 1999)

The second issue to be resolved was the distinction between subsoil and topsoil. The topsoil is the upper soil layer within which plants root and most soil fauna lives. In soil policy the distinction between subsoil and topsoil was never made before; soil policy applied to topsoil. In the third episode the distinction became relevant to make because the connotation of soil began to change from an environmental resource to an economic resource. Building and construction as economic activities are not limited to topsoil, but increasingly take place in subsoil. As a consequence the distinction between topsoil and subsoil became relevant. The subsoil refers to deeper soil, where digging and construction works take place. The standard approach to be followed for the treatment of an immobile pollution was to create a surface layer (with SRO as soil quality standard). The thickness of the surface layer depended on the soil-use type, as can be seen in Table 7.2. In its advice, TCSP criticised this proposal for the relative thin surface layer. TCSP argued that activities like building and tree growth were insufficiently taken into consideration and advised to increase the thickness of the surface layer. TCSP advised a standard thickness of 1.5 meter to which the Soil Remediation Objective would apply. Core team A did not adopt that suggestion. In addition, TCSP considered a surface layer approach inadequate for agriculture and nature. Apparently, the Core team did not adopt that suggestion either and maintained its proposal for the thickness of the surface layer in its final report.

Table 7.2 Soil use types and target values for the thickness of a surface layer (BEVER regiegroep 1999). The four land-use types are explained in Section 7.3.

Soil-use type		**Thickness of surface layer (in cm)**
I	Residential and recreational green areas	50 – **100** – 150
II	Non-recreational green areas	50 – **100** – 150
II	Built-up and paved areas	0
IV	Agriculture and nature	Tailor-made approach

The third issue that had to be resolved was the establishment of land-use types and the remediation objectives. The development of these remediation objectives and the land-use types is analysed in depth in the following sections.

7.3 Current state of knowledge and labelling usable knowledge

The labelling of usable knowledge developed for these remediation objectives for immobile pollution consisted of two steps. In the first step, the soil-use types were identified. The RIVM proposed to distinguish seven soil-use types and developed user criteria and minimum soil quality criteria. In soil policy a distinction in soil functions had been made in the first episode (see Chapter 4, episode 1): a carrier function, water supply, production (agriculture and mining) and an ecological function had been distinguished, but these were never translated to land use and specific soil use. In the first episode, under the guiding principle of multifunctional soil quality, the ecological function was identified as the most vulnerable. This most vulnerable function was used to derive standards for soil quality. The identification of the other functions became irrelevant. In soil policy the carrier function, water supply function, production function (agriculture) and the ecological function had been distinguished, but these were never translated to land use or to specific soil use.

With the transition to function-oriented remediation, this operationalisation was required in environmental policy. The RIVM was assigned the task to derive a classification of functions that would meet the requirements of environmental policy, spatial planning and housing. The RIVM organised the process in five steps:

1. *Identification of <u>soil functions</u> (land use based)*
2. *Identification of <u>soil use</u> per function*
3. *Identification of <u>minimal soil requirements</u> per function.*
4. *Identification of soil quality criteria.*
5. *Identification of the most restrictive criterion and use this to calculate <u>soil-use specific clean-up objectives</u> (BGW).*

The RIVM used the classification of functions as it is used in spatial planning as a point of reference and left the distinction of functions from the Soil Protection Act untouched. The RIVM developed an initial classification of soil use that consisted of seven classes:

1. *Housing with vegetable garden*
2. *Housing with garden*
3. *Housing without garden*
4. *Industrial areas/infrastructure*
5. *Public green space and recreation*
6. *Agricultural areas*
7. *Nature areas*

In the third step, the RIVM derived minimum soil-use requirements for each soil-use class (step 3) and an operationalisation for the soil quality criteria (step 4). For example, for the first class of soil use (housing with vegetable garden) the RIVM posed as a soil-use requirement that the consumption of home-grown crop would amount to 10-50% of total crop consumption. As a contrast in the second soil-use class, a maximum of 10% of total crop consumption consists of home-grown crops. Such criteria were developed for all seven classes. In the fourth step (Identification of soil quality criteria) four different soil-use criteria were derived.

- *Human health soil quality criterion*
- *Soil quality criterion for plants*
- *Ecological soil quality criterion*
- *Additional soil quality criteria*

In other words, soil quality for each land use class, would have to be evaluated for these four criteria. This distinction into four quality criteria differs from the distinction into two quality criteria used in the previous case study, where a differentiation was made between the criteria: risk to human health, risk to ecosystem health (mainly operationalised as risks for soil fauna) and risk of diffusion of pollution (Chapter 6, Section 6.4). The first criterion (Human health soil quality) concerns human health. Further explanation of this criterion is beyond the scope of the thesis.

The second criterion (Soil quality criterion for plants) is remarkable. In this case study a separate criterion was included for plant growth. This is illustrative of the difference between the second and third episode. In the second (and first) episode, plant growth and soil quality was studied in relation to agronomic issues and agricultural use of soil. This relation was not studied in the context of the protection of nature and environment. The body of knowledge on plant growth and soil quality as developed at Wageningen University was largely out of sight once the ecological function was selected to be the most vulnerable. In addition, as described in the second case study, scientists refrained from including plant scientists in the previous episodes as this would complicate and fragment the available resources for scientific research. For these reasons, plant growth and phytotoxicity (toxicity for plants) was not explicitly included in the previous cases. It is therefore remarkable that it appeared as a separate criterion here. In the new approach, plant growth, either for recreational, nature or consumption purposes became a distinctive characteristic of soil use. However, as we will see, this was a short-lived phenomenon only.

The third soil quality criterion (ecological soil quality) concerns ecotoxicological risk assessment as developed in the previous episode. The RIVM proposed three different and alternative methods to assess ecological soil quality. The first was to apply the approach used to calculate the target and intervention values. The target values are set at 1% of the HC5 (the concentration above which 5% of the species in the system is exposed to concentrations above their No-Observed-Effect-Concentration (NOEC)). For the least vulnerable soil use, other HC values could be used ($HC_{10,\ 20}$ or $_{50}$). The second alternative proposed in the RIVM study was to identify key species and key processes per soil use and to establish the concentration levels at which a certain percentage of the species is affected. This approach was developed in a study commissioned by TCSP (Van Hesteren et al. 1998). The third alternative took a different approach and focused on actual site-specific risks instead of the potential risks calculated with the first two alternatives. This method was developed by researchers from the RIVM, RIZA and IBN. The core of the method was an integrated assessment of actual risks based on on-site chemical, ecological and ecotoxicological measurements on the spot (Rutgers et al. 1998). The first alternative was already available and did not require further research. The second alternative required some additional research, but most of the data were already available and similar to the data required for the first alternative. The third alternative concerned conceptual and ambitious work in progress. Application of this third alternative would require additional time and resources to further develop the approach. Especially the time constraint was problematic As it was considered a promising approach, further work on this alternative was stimulated.

The fourth criterion (Additional soil quality criteria), included existent quality criteria developed on other issues. Two of these additional quality criteria were BOOM, referring to quality standards for recycling organic waste by applying it as a fertiliser and BAGA, referring to criteria used for dangerous waste. Cadmium (Cd), mercury (Hg) and arsenic (As) are industrial substances and quality criteria for these substances were considered relevant to land-use type 4 (see Table 7.3).

At a later stage, the four soil-use criteria were regrouped; the 'soil quality criterion for plants' and the 'ecological soil quality criterion' were clustered and renamed as 'ecotoxicological criteria'. This ended the short-lived use of a separate soil quality criterion for plants. Table 7.2 shows that three soil quality criteria remained: human health, ecotoxicological and additional criteria. Now that the land-use types had been distinguished, and soil quality criteria had been developed, soil-use specific clean-up objectives could be developed according to the fifth step in the RIVM proposal. These soil-use specific clean-up objectives had to be developed according to existing methods and available datasets. Of these, the method that produced the most critical value per substance and soil-use type was selected as the most critical user criterion. The soil-use specific clean-up objective was calculated according to that method. For each of the soil-use types, Table 7.3 below gives the calculation methods that have produced the soil-use specific clean-up objective (later Soil Remediation Objective).

Table 7.3 Approaches to calculate the remediation objectives for the seven soil-use types developed by the RIVM. MTR_{eco}, phytotoxicity, HC_{50}, Other LAC, $Eco_{process}$, refer to ecotoxicological criteria. BOOM refers to: requirements in relation to recycling organic waste. BAGA refers to: Decree on dangerous waste. Both BOOM and BAGA are grouped as 'additional criteria'. Human refers to human health quality criterion.

	1 Housing with vegetable garden	2 Housing with garden	3 Housing	4 Industrial areas	5 Public green space	6 Agriculture	7 Nature
Cr	MTR_{eco}	MTR_{eco}	HC_{50}, $Eco_{process}$	HC_{50}, $Eco_{process}$	$Eco_{process}$	MTR_{eco}	$Eco_{process}$
Ni	MTR_{eco}	MTR_{eco}	HC_{50}	HC_{50}	BOOM	MTR_{eco}	phytotoxicity
Cu	MTR_{eco}	MTR_{eco}	HC_{50}	HC_{50}	phytotoxicity	MTR_{eco}	other LAC
Zn	phytotoxicity	phytotoxicity	HC_{50}	HC_{50}	HC_{50}	phytotoxicity	phytotoxicity
Cd	BOOM	BOOM	HC_{50}	BAGA	BOOM	BOOM	BOOM
Hg	MTR_{eco}	MTR_{eco}	HC_{50}	BAGA	BOOM	MTR_{eco}	other LAC
Pb	human	MTR_{eco}	HC_{50}	HC_{50}	human	MTR_{eco}	other LAC
As	phytotoxicity	phytotoxicity	HC_{50}	BAGA	HC_{50}	phytotoxicity	phytotoxicity

Ecotoxicological criteria appear as the most vulnerable (used 44 times). Human health criteria appear 2 times, while additional soil quality criteria (Boom and BAGA) appear 10 times.

The classification in Table 7.3 was used by Core team A in the draft version of its report. In its advice on the concept report, TCSP recommended to reduce the number of soil-use types as this fine-grained differentiation would introduce implementation problems. For instance differentiation between housing with vegetable garden and housing with garden was difficult to establish and difficult to control. TCSP advised to differentiate between intensively used and extensively used land use. In June 1999, Core team A asked the RIVM to develop a new classification and posed that the number of soil-use types had to be reduced. After this intervention by the Core team, the RIVM clustered the soil-use types and produced the so-called Core team variant 2:

- *Cluster I included soil-use types 1, 2, 6, and 7*
- *Cluster II included soil-use types 3, and part of 4 (industrial sites with open surface)*
- *Cluster III included soil-use types 5*
- *Cluster IV included part of soil-use type 4 (industrial sites with paved surface)*

In response to this outcome, the Core team stated that exposure in Cluster IV was negligible and that, consequently, no standards had to be derived.

Table 7.4 Two approaches to calculate the remediation objectives for the three soil-use clusters developed by the RIVM in response to Core Team variant 2. HC_{50}, and LAC refer to Ecotoxicological criteria. Human refers to Human health quality criteria. The three soil-use clusters grouped the previous soil-use types as follows: Cluster I: housing with vegetable garden, housing with garden, agricultural areas, nature areas. Cluster II: housing without garden, industrial areas/infrastructure with open surface. Cluster III: public green space and recreation.

	Cluster I	**Cluster II**	**Cluster III**
Cr	$HC_{50\ process}$	$HC_{50\ process}$	$HC_{50\ process}$
Ni	$LAC_{phytotoxicity}$	$HC_{50\ process}$	HC_{50}
Cu	LAC_{other}	$HC_{50\ process}$	$HC_{50\ species}$
Zn	$HC_{50\ process}$	$HC_{50\ process}$	$HC_{50\ process}$
Cd	LAC_{other}	$HC_{50\ process}$	$HC_{50\ species}$
Hg	LAC_{other}	$HC_{50\ process}$	$HC_{50\ species}$
Pb	human	$HC_{50\ process}$	$HC_{50\ species}$
As	$HC_{50\ species}$	$HC_{50\ process}$	$HC_{50\ species}$

During the project Core team A asked the RIVM to make visible how changes in the soil-use requirements affected the height of the soil remediation objectives. The RIVM calculated a number of variants making clear that considerable differences in the height of the standards could be produced by changing the soil-use requirements. One of these variants was based on a proposal by Core team A (Core team variant 1) about what soil uses to include and which ones to exclude. These interventions by the Core team are clear examples of boundary work between science and policy in the development of these standards: Who had the authority to identify the number of classes in the soil-use typology? If the RIVM was given the task to produce a classification, why did the Core team intervene with a directive about the number of classes? This issue is discussed in Section 7.5. In addition, the Core team stated that the 'additional soil-use criteria' were irrelevant. The RIVM went through the whole procedure again and proposed a new classification, given in Table 7.4.

In commenting on this proposal, the Core team now voiced its wish to make a separate class for agriculture and nature. This was another intervention by the Core team that was not welcomed by the RIVM. The resulting classification (Core team variant 3) was used to proceed with the development of soil remediation objectives. Core team A now used the following four categories of land use:

1. *Housing and intensively used (public) green space (subset of the above Clusters I and III)*
2. *Extensively used (public) green space (subset of the above Cluster III)*
3. *Construction and pavement (subset of the above Cluster II)*
4. *Agriculture and nature (subset of the above Cluster I)*

This regrouping of the land-use types implied a regrouping of the remediation objectives. The grounds for this rearrangement of soil-use types were pragmatic. First, this classification was in line with the land use typology used in spatial planning. Second, this classification allowed a customised approach per case for agriculture and nature. This shows that the grounds for the typology were only partly grounded in the actual soil quality requirements. Rather, the land-use type classification seems to be based on three considerations First, the similarity of interventions. In agricultural areas, interventions to restore soil quality had to be attuned to agricultural practices. In nature areas these interventions had to be attuned to nature management interventions. With respect to soil quality requirements, these are clearly different for agriculture and nature. Second, the administrative and political responsibility for land-use types. Agriculture and nature policy fell under the responsibility of one ministry. Third, exposure and hence the need and possibility to intervene. The third category (construction and pavement) includes land-use types where both human and ecosystem exposure is limited. These four categories of land use have been used for the development of soil remediation objectives. In Section 7.4 the final proposal for the soil remediation objectives is given.

Besides the establishment of the remediation objectives, mobile and immobile pollution, and the thickness of the surface layer, two more issues had to be resolved as mentioned at the beginning of Section 7.2. The fourth issue was the distinction between a standard treatment and a customised approach. The fifth issue was the distinction between a customised approach per case, and a customised approach per area. The standard approach consisted of the application of a surface layer on top of the polluted soil. The differentiation between a tailor-made approach per case and per area entailed the risk of inequality of soil quality. Location-specific approaches could result in a different soil quality that differs per individual site. The legal responsibility of national government (in this case, the Ministry of Public Housing, Spatial Planning and the Environment) to safeguard the generic soil quality urged the ministry to set the degrees of freedom in location-specific treatments.

The results of the work by Core team A were published in 1999: From Funnel to Sieve (BEVER regiegroep 1999). The title of the document refers to the difference between a funnel and a sieve: The flow of treatment projects can get blocked if a large project blocks the funnel. Once a large project blocks the funnel, not even small and simple projects can pass through. Through a sieve, the relative simple and small treatment projects can pass, leaving the large and complex projects behind for a customised approach. The metaphor of funnel and sieve is used to illustrate the attempt to reduce the stagnation that can result from blocking the funnel by replacing it by a sieve.

The report 'From Funnel to Sieve' meant to set the boundaries of the breathing space for the formulation of location-specific treatment. The report did not treat all aspects of the work of Core team A as some issues were not yet resolved. For instance, the customised approaches, per case and per area were developed later as they turned out to be thorny issues. In the report, not more than a start was made with the appraisal process for subsoil, i.e., mobile pollution. The concept of 'stable end situation' was introduced, to denote that treatment would have to be geared towards stabilisation of the plume of mobile pollution, spreading from the source. The policy regarding mobile pollution was not fully fleshed out.

At this stage, the TCSP commented on the report by the Core team. The committee stressed to develop a policy for the monitoring and 'Aftercare of mobile pollution' (TCB 1998). In addition, the committee anticipated a 'new' attitude to soil quality, in which environmental quality became subordinate to economic value. The connotation of soil began to include soil as a resource for social and economic development. The committee finally urged to reflect on this while further developing the practice of active soil management.

7.4 Setting the standards

In the report by Core team A, the following land-use types had been distinguished.

1 *Housing and intensively used (public) green space*
2 *Extensively used (public) green space*
3 *Construction and pavement*
4 *Agriculture and nature*

The soil remediation objectives for the first two land-use types were published in their report. For the third function no standards were derived. The motivation was that there was no exposure, as it concerned paved surfaces. For the fourth function it was initially decided to apply the LAC-signal values for the agricultural activities. However, these values were being evaluated at that moment, and the final decision about the soil remediation objectives were postponed until the reviewed LAC signal values were established.

Table 7.5 Approaches applied to derive soil remediation objectives for the four land-use types finally proposed by the RIVM 1 (Lijzen et al. 1999b).

	1 Housing and intensively used (public) green space	**2 Extensively used (public) green space**	**3 Construction and pavement**	**4 Agriculture and nature**
Cr	LAC-phytotoxicity	HC50	-	LAC
Ni	LAC-phytotoxicity	HC50	-	LAC
Cu	LAC-fodder	HC50	-	LAC
Zn	LAC-phytotoxicity	HC50	-	LAC
Cd	LAC-food	HC50	-	LAC
Hg	LAC-food	HC50	-	LAC
Pb	MTL-human (children)	HC50	-	LAC
As	HC50	HC50	-	LAC

Table 7.5 shows the variety of approaches to calculate standards for soil quality. The LAC values are standards developed and applied in agricultural policy. In this policy field, standards for soil quality are calculated based on standards for substances in food products. A differentiation is made between different agricultural products; those for human use (LAC-food), animal consumption (LAC-fodder), and phytotoxicity (LAC-phytotoxicity). The HC50 values have been used to derive the intervention values (see Chapter 7). The MTL-human (used to calculate the SRO for lead (Pb) in land-use type

1 refers to the Maximum Tolerable Level for human (children's) health. Table 7.6 gives the concentration levels calculated with the above approaches. HC50 and MTL levels are given for standard soil. The correction formulas for different soil types as developed for the reference values and applied as correction factors for target- and intervention values apply (see Chapter 5 for a detailed explanation of these soil type correction factors). LAC-values are given for clay as the best approximation of standard soil (10% organic matter, 25% lutum content).

Table 7.6 Soil remediation objectives for the four land-use types compared to the target and intervention values (Lijzen et al. 1999b). All concentrations are given in mg/kg dry soil.

	1 Housing and intensively used (public) green space	2 Extensively used (public) green space	3 Construction and pavement	4 Agriculture and nature	Target values	Intervention values
Cr	300	380	-	200-300	100	380
Ni	50	210	-	15-70	35	210
Cu	80	190	-	30-200	36	190
Zn	350	720	-	100-350	140	720
Cd	1	12	-	0.5-10	0.8	12
Hg	2	10	-	2	0.3	10
Pb	85	290	-	100-800	85	350
As	40	40	-	30-50	29	55

What stands out in these tables is the variety of the scientific approaches used to calculate the SROs reflecting the combination of models and approaches developed before.

7.5 From case to context

The soil remediation objectives were produced within the context of the BEVER project. The standards were regarded as one of the outcomes of the soil policy renewal and therefore had to fit, more than before, administrative processes.

7.5.1 Giving meaning to function-based soil quality

The incentive to derive soil remediation objectives was the recognition that the availability of soil of a certain quality is crucial to processes other than from the environmental policy subsystem alone. Housing, construction, agriculture; all depended on soil quality. Stagnation of cleanup because of environmental considerations led to stagnation in these policy subsystems and this was no longer acceptable. The connotation of soil changed from an environmental compartment towards a societal good. This changed connotation translated into the decision that the standards had to be related to social activities. The land-use types had to reflect this renewed connotation. Clearly, this is the case as land-use types 1, 2 and 3 refer to housing and economic activities while land-use type 4 refers to agricultural activities (and nature). Similarly, the approaches in Table 7.2 reflect this wider connotation.

Under the heading of active soil management, slightly contaminated soil could be transported to other sites, and reused as surface layers (see Table 7.1). However, the Building Materials Decree applies when transport and reuse are involved. Under the Building Materials Decree, slightly contaminated soil with concentrations exceeding the intervention values was not allowed to be reused. In the new soil policy this soil quality (exceeding the intervention values) can be applied as surface layer in soil-use type III, construction and pavement. This example illustrates the type of incompatibilities between soil policy and the Building Materials Decree.

7.5.2 Decentralising policy development

One of the initiatives that led to the formulation of soil remediation objectives was the critical comment on existent soil policy by the Association of Netherlands Municipalities (VNG) made as early as 1992 and 1995. The VNG opposed the then current soil policy as it frustrated building and construction activities. A classic example illustrating the implementation problem was that in order to obtain permission to build a small extension to a house such as a veranda, the soil quality had to be checked, and if any contaminant concentration exceeded the intervention value, no permission could be given and further analysis was required to determine the urgency of the treatment of the pollution. It was generally acknowledged that the application of these standards in such situations was beyond their purpose. The VNG used such dramatic examples to encourage the discussion about function-based soil quality standards.

The Directorate General of the Environment within the Ministry of Public Housing, Spatial Planning and the Environment took up the challenge, and, in discussion with the Directorate General of Housing within the same ministry responded to the VNG with the proposal to develop the soil remediation objectives. They did not adopt the standards proposed by the VNG. This response created the momentum needed by the VNG and the IPO to become more active and authoritative in policy formulation. From interviews during the research, it became clear that the Ministry of Public Housing, Spatial Planning and the Environment struggled with finding a new niche now that new actors had been invited at the standard-setting table. In other words, one of the issues characteristic of this case study was the clarification of the roles of the national government in relation to regional and local authorities. On the face of it, part of the decision-making authority was transferred from national government to local and regional governments.

7.5.3 Whose task; regulatory science or policy?

In the BEVER project, three meetings were scheduled with experts. Each meeting had a specific subject. Here, the first meeting is relevant. In a group of 14 experts a discussion was organised on SROs and the surface layer. The expert group represented the stakeholders; municipalities, provinces, the Ministry of Public Housing, Spatial Planning and the Environment, Industry, Environmental NGOs, Core team A, and the TCSP. Scientists employed at universities and experts on soil were not directly represented. The members of the expert meeting were experts with respect to the development and implementation of soil policy, more than with respect to soil quality in a scientific sense. The qualification of expert shifted from scientists, knowledgeable on technical aspects of risk assessment, towards people who are knowledgeable on soil policy and implementation. These two characteristics of the context are crucial to an understanding of the labelling of usable knowledge in this third case. It is apparent from the documents and interviews that there were difficulties in defining whose task it was to define the land-use types, the user criteria and the quality criteria (see (Lijzen et al. 1999a) and correspondence of the chairperson of Core team A with the project manager at the RIVM (Roeters 1999; Swartjes 1999)). The interaction between the RIVM and Core team A was troubled by communication problems that could be traced back to uncertainties about the division of roles and responsibilities for aspects of the development of the SROs. It was not only the limitation in time that altered the co-production seen so clearly in the second case study on the development of target and intervention values. The envisaged policy change was not a cognitive change as much as the previous two cases. The six aspects listed in the Target Perspective that set the contours for the policy change were almost exclusively about process changes. The normative dimension of the context dominated the policy renewal. In unfolding the process of labelling usable knowledge it has become clear that the relation between science and policy, notably the relation between the RIVM researchers and Core team A was unclear. In one of the BEVER draft reports the following argumentation was given for the labelling of usable knowledge:

> The above choices enable an interpretation of the SROs resembling the intervention values as much as possible. This prevents a complete new research programme having to be installed to provide scientific underpinning for the SROs. The information for these parameters (HC_{50}, MTL, LAC) has already been discussed for other purposes (intervention values).
> (BEVER regiegroep; From Funnel to Sieve, February 1999 p. 39)

Although the argumentation for labelling has not changed, in the final version of From Funnel to sieve a different signal concerning the outlook for research activities was given to researchers.

> The choices made above make an interpretation of the SROs possible which comes as close as possible to existing soil quality criteria and methods. …For the sake of future improvements to the SRO system, therefore, a research programme is being developed for which the Ministry of Public Housing, Spatial Planning and the Environment will be responsible.
> (BEVERregiegroep; From Funnel to Sieve, October 1999 p. 66)

The responsibility of Core team A was to decide about the land-use types, the user criteria and the related minimum soil quality criteria. They did this in close contact with the RIVM. After deliberations within Core team A and the BEVER control and steering group, the Core team decided that the number of functions should be reduced to four, that the Core team had to decide about the user criteria and that the RIVM would then be invited to derive minimum soil quality criteria. Similar to the previous two case studies, significant steps in the labelling of usable knowledge were taken in an early stage. The formulation of policy goals or objectives implied what was going to be usable knowledge. In this third case study, the degrees of freedom for scientists to produce new knowledge were reduced to a minimum, so to speak. Core team A asked the RIVM to provide scientific underpinning for a function-based approach in less than a year. In this case study, boundary work took place between regulatory science and policy. The distinction of the land-use types made this boundary work visible. It was unclear at the start of track A how responsibilities were demarcated resulting in an intense debate between the RIVM and Core team A about these responsibilities.

7.5.4 Increasing number and diversity of involved actors

In the Target Perspective laying the groundwork for the development of the SROs, a more participatory appraisal process was advocated. Provincial and local authorities claimed a position at the table. Other parties also became involved, such as the representatives of Small and Medium Enterprises (SMEs) and the Confederation of Netherlands Industry and Employers (VNO-NCW). All parties with stakes concerning the quality of soil were invited to participate. Together with the broadening of policy fields that use soil quality standards, this increased number and diversity of participating actors was meant to increase the use and acceptance of soil quality standards and reinforce these actors' commitment and involvement. It has also made the development of standards an even more complex and time-consuming project. Such increase in the numbers and diversity of actors requires a careful definition of the tasks, responsibilities and roles of all parties involved, as well as of what is expected of them.

7.5.5 Creating meaning to standards and the classification of soil quality

The meaning of soil quality standards changed in several ways. First and foremost the generic reach of soil quality standards was traded in for a function-based approach. Exceeding the standard in the previous case studies was an indication of a potential risk. In the previous case studies, standards were developed to indicate actual risk. Exceeding the intervention values indicated that over 50% of the species was exposed to above their NOEC. This was interpreted as an indication of potential risk and provided grounds to schedule treatment. Actual and local risk assessment was not determined. The grounds for treatment were based on standards that were grounded in generic and potential risk indications. In the present case study, the grounds for treatment shifted towards the establishment of actual and local risks. This is a less precautionary approach. Soil pollution has shifted from an environmental problem towards an economic and social problem; solving the environmental problem has been traded for solving an economic and social problem, under the flag and responsibility of environmental policy. This shift is materialised in the development process of standards that I have unfolded in this case study. I uncovered the argumentation for the calculation of the different standards for land-use types in an attempt to clarify the meaning behind the figures of the standards. Standards simplify and reduce complex decision-making to dichotomies. That is the strength of standards. Once soil policy develops other instruments to support complex decision-making, the strength of standards as policy instruments diminishes.

A second shift in the meaning of standards is that the soil remediation objectives have made soil quality depend on land use; a spatial planning perspective has been included in environmental policy-making. This will invoke new dynamics in soil policy. On the one hand because SROs, like any quality standard, have a performative meaning and will change soil policy development and implementation. Figure 7.1 shows the proliferation of the classification of soil quality. The implementation of SROs has increased the complexity of the framework for soil quality standards and suggests that this will simplify the implementation of soil treatment.

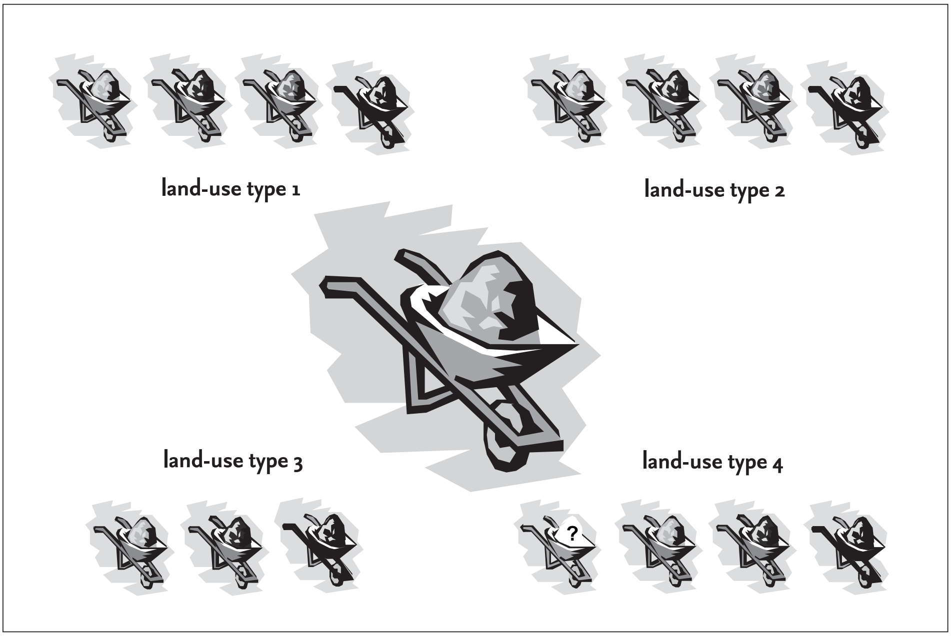


Figure 7.1 Classification of soil quality after the introduction of SROs. First of all, the SROs classify soil into 4 land-use types. For land-use type 1 (housing and intensively used public space) and 2 (extensively used public space) soil quality is classified into soil that meets target values, soil that meets SROs, soil that is severely polluted (exceeding the intervention values) and soil that is severely polluted and has to be treated urgently. For land-use type 3 (construction and pavement) no SROs are derived. Even if soil is severely polluted and qualifies for urgent treatment, no target for treatment is given. For land-use type 4 (agriculture and nature), soil quality is classified into: soil that meets the target values; soil that exceeds the intervention values; and soil that is severely polluted and has to betreated urgently. The question mark of the fourth class refers to the fact that for land-use type 4, the soil remediation objectives are determined per case.

7.6 Conclusions

In Chapter 3, research questions 2 and 3 were formulated for the case studies.

2. What knowledge is labelled as usable knowledge?
3. What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context?

This section answers the research questions for the third case study. The (disciplinary) background) of knowledge that is labelled as usable is described. Also, the relation between the arguments applied in labelling and the institutional context is given.

Related to the second case study, research question 2 (What knowledge is labelled as usable knowledge?) can be answered as follows. For the distinction of land-use types, approaches from spatial planning were labelled as usable for the classification. In the light of policy development in the third episode this is not surprising; perspectives from spatial planning policy were introduced in soil policy, moreover, in one of the BEVER projects approaches in spatial planning policy were valued over environmental policy (see Chapter 4, Section 4.3.2). From a soil policy perspective it is interesting to compare the development of this typology with the soil function typology developed in the first episode (see Chapter 4, episode 1 and Chapter 5). Several typologies were developed at that time and co-existed. The need to further elaborate on that classification at the time was absent; once the ecological function had been qualified as the most restrictive and therefore the function for which a protective soil policy would have to be put in place, it was virtually irrelevant to develop the typology further. To my knowledge, a revision or reconsideration of the soil function typology developed in the first episode was not part of the development of the function-based typology in this case study. The observation that the typology developed in episode 1 was not used in this third episode further supports my conclusions that the principle of multifunctionality was useful and even crucial in the first episode to establish a position for soil policy (within the Ministry of Public Health and the Environment in the 1980s and also in relation to the Ministry of Agriculture, Nature, and Fisheries). For the development of the SROs scientific knowledge related to flanking policy fields was labelled as usable; LAC standards were labelled as usable, together with the scientific knowledge that had been labelled usable in the previous case study: ecotoxicological knowledge.

Research question 3 (What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context?) can be answered as follows. The regulative dimension plays a role, insofar as the revision of the Building Materials Decree made it clear that standards for soil quality applied to that legal framework as well. This provided an argument to develop standards that took the interests from that sector into consideration. The arguments for labelling manly concerned the normative dimension. The increasing number and diversity of actors and policy fields related to soil quality standards (notably the Building Materials Decree) made it clear that standards had to facilitate the cooperation of these actors, which urged for the approval of involved parties in the development of these standards. This became a point of departure through the Target Perspective. It was the difficult task for Core team A to develop these standards in a fast changing environment taking these different perspectives and interests into consideration.

Arguments related to the cognitive dimension were apparent; soil was reframed from an ecological, environmental compartment, worthwhile to be protected as a resource for economic activities and development. This was reflected in the development of a land use typology that reflected not only soil as an environmental compartment but also as an economic resource.

CHAPTER 8

Conclusions and discussion

This chapter discusses the main conclusions of the research. The chapter consists of three sections. Section 8.1 answers the research questions. Section 8.2 discusses these answers in terms of the perspective and guiding question from Chapter 1. The third and final section of this chapter provides a reflection on the methodological and theoretical approach.

8.1 Answers to the research questions

This research interprets the development of standards as a process involving both science and policy and taking place at the overlap of science and policy (see Figure 1.4). It further argues that the concentration levels of substances in the soil (which is how standards for soil quality are manifested) conceal the complex development process. One aspect of that development process was selected in this thesis as the research object: the labelling of usable knowledge. In Chapter 3 the approach was further specified and explained in the interpretative framework. At the end of Chapter 3, five research questions were formulated. Before formulating the answers to each of the research questions the guiding question is repeated here:

> *How can we understand the labelling of usable knowledge for the development of soil quality standards in terms of boundary work between science and policy and in terms of the relation between regulatory practice and its institutional context?*

In Chapter 3 a literature review was included as well. The conclusion of that review was that the concept of boundary work was insufficiently fleshed out as an analytical perspective. As a way forward it was proposed to complement it with the concept of institutional context. From that latter perspective the labelling of usable knowledge could be interpreted as a process within regulatory practice that in turn was embedded in an institutional context. In doing so, it became more than just interesting to understand the arguments applied in labelling as boundary work between science and policy. The arguments applied in labelling now also anchored regulatory practice to its institutional context, in which a variety of actors, interests and issues participated. Without giving up the concept of boundary work in the interpretation of the empirical material brought together in this thesis, the question thus transformed into how regulatory practices are related to their institutional context. The guiding question thus was redefined into the following five research questions.

1 How can the institutional context be characterised? (Chapter 4)
2 What knowledge is labelled as usable knowledge? (Chapters 5, 6, 7)
3 What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context? (Chapters 5, 6, 7)
4 How does regulatory practice develop during the research period? (Chapter 8)
5 How do the dimensions of the institutional context affect the labelling of usable knowledge in regulatory practice? (Chapter 8)

Throughout the research focus has been on the application of the institutional context as a concept to further our understanding of the interaction between science and policy in labelling usable knowledge.

8.1.1 Characterisation of institutional context

In Chapter 4 the recent history of setting standards for soil quality was described, which is organised in three episodes. Each of these episodes was characterised in terms of the three dimensions. A short and simple answer to the first research question is not possible. Table 8.1 gives an overview of the critical events, achievements and developments on the regulative (first row), cognitive (second row) and normative dimension (third row). The table is explained more extensively in the text below.

The first row concerns the regulative dimension, and reveals a developing policy field; in the first episode the legal framework (Soil Protection Act and Interim Soil Pollution Act) was constructed. As explained in Chapter 4, Section 4.1.1, the development of a legal framework for soil policy was delayed. First, soil was initially perceived as a resource available for infrastructural works, for agriculture and mining.

Table 8.1 Assembled from the tables in the concluding sections of each episode in Chapter 4. For each episode and dimension critical events, achievements and developments are listed.

	Episode 1; 1971-1988	Episode 2; 1989-1994	Episode 3; 1995-2000
Regulative	• Interim Soil Pollution Act (1983) • Soil Protection Act (1987)	• Integration of Interim Soil Pollution Act and Soil Protection Act (1994)	• Revision Soil Protection Act (1994) • Cabinet's position (1997) • Building Materials Decree (1999)
Cognitive	• Multifunctionality	• Risk approach • Multifunctionality	• Function-based quality • Risk approach • Multifunctionality
Normative	• Carving out a department (sector) for soil quality at the Ministry of Public Health and the Environment • Disputes between ministries over authority to regulate soil quality • Establishing the Technical Committee on Soil Protection • Soil research programmes (Soil Protection, Soil Ecology, Netherlands Integrated Soil Research Programme SPBO)	• Active soil management • Increase in number of actors involved in policy development (notably the VNG, the IPO) • Integration of environmental policy fields • Criticism with regard to abstract and insufficiently operational principles guiding soil policy • Soil research programme (Netherlands Integrated Soil Research Programme SPBO)	• Active soil management • Soil policy renewal: BEVER, six aspects from Target Perspective • Soil research programmes (PGBO, NOBIS, SKB)

The perception of soil as an environmental compartment worthwhile to be protected was late to develop. It trailed behind the perception of the protection of the other two environmental compartments (air and water). Second, and related: political fencing delayed the development of the legal framework. What speeded up the development of the legal framework was the discovery of hotspots of pollution like Lekkerkerk, the suburb that was built on polluted soil. In need of a legal framework to guide the immense treatment operation, the Interim Soil Pollution Act was developed at high speed. The development of the Soil Protection Act was further delayed and not accepted before 1987. In the second episode these two frameworks were integrated. In the third episode the regulations from other flanking policy fields get connected. The Building Materials Decree includes regulations about the quality of soil that is used and transported for building and construction works. In the third episode the Soil Protection Act was revised.

A closer look at the second row (cognitive dimension), reveals the increasing number of concepts (principles). In the first episode, the principle of multifunctionality was introduced as the guiding principle in soil policy. In the second episode, the risk approach was introduced in environmental policy and applied to soil policy as well. It was introduced to set priorities in environmental policy by 'defining' different risk levels (the negligible level (NL) and the maximum tolerable level (MTL)). In addition, the risk approach was introduced to harmonise the development of standards for the three environmental compartments (soil, air and water). The risk approach did not replace the guiding principle of multifunctionality, as it had a wider reach and applied to environmental policy in general. In the third episode, the concept of function-based quality was introduced as part of a renewal of soil policy. Like the risk approach, this concept also did not replace the earlier concepts, but complemented these. Function-based quality introduced a differentiation between the functions of soil. Whereas previous concepts stressed the sameness of soil quality irrespective of land use, the concept introduced in the third episode did just that. It led to a differentiation of soil quality standards for different land-use types.

It could be argued that the concept of multifunctionality was the point of departure, not only for policy development, but also for the formulation of the research agenda of the largest soil research programme, the Netherlands Integrated Soil Research Programme; SPBO. This statement must be qualified immediately, as it should be noted that it was not so much the principle of multifunctionality that was used as a point of departure, but rather the identification of the ecological function as the most vulnerable one. This has directed the development of soil research that began to focus on the ecotoxicological effects of potentially toxic substances. As was shown in Chapter 7, the concept of function-based quality as such referred not so much to a development of new scientific knowledge, but mostly to the practice of implementing standards. Compared to the previous two concepts, this concept was introduced to facilitate the progress of soil policy and treatment and available scientific knowledge was used to underpin this concept by developing an operationalisation consisting of a land use typology and related soil quality standards. It must be noted here, that the development of alternative methods to assess site-specific and actual risks was stimulated meanwhile.

Standards for soil policy are treated in this thesis as instruments in soil policy, which in turn is embedded in environmental policy. In this 'hierarchy' (see Figure 8.1) the different cognitive concepts discussed in this thesis (multifunctionality, risk approach, function-based quality) are located in different positions. In Figure 8.1 the cognitive concepts are positioned in this hierarchy with environmental policy principles at the bottom and soil quality standards at the top. The concepts at the bottom are generic principles in environmental policy ('limits to growth' and 'sustainability'). Towards the top of the triangle the concepts are more specific in soil policy and soil quality standards. For instance, in the second episode the risk approach was introduced. This concept pertains to environmental policy. The risk approach is therefore more generic than the principle of multifunctionality which pertains to soil policy only, and is therefore positioned between 'multifunctionality' and 'limits to growth'. In the third episode, the principle of multifunctionality was complemented by the concept of function-based quality insofar as the latter applies to immobile pollution originating from before 1987 (the year the Soil Protection Act was implemented).

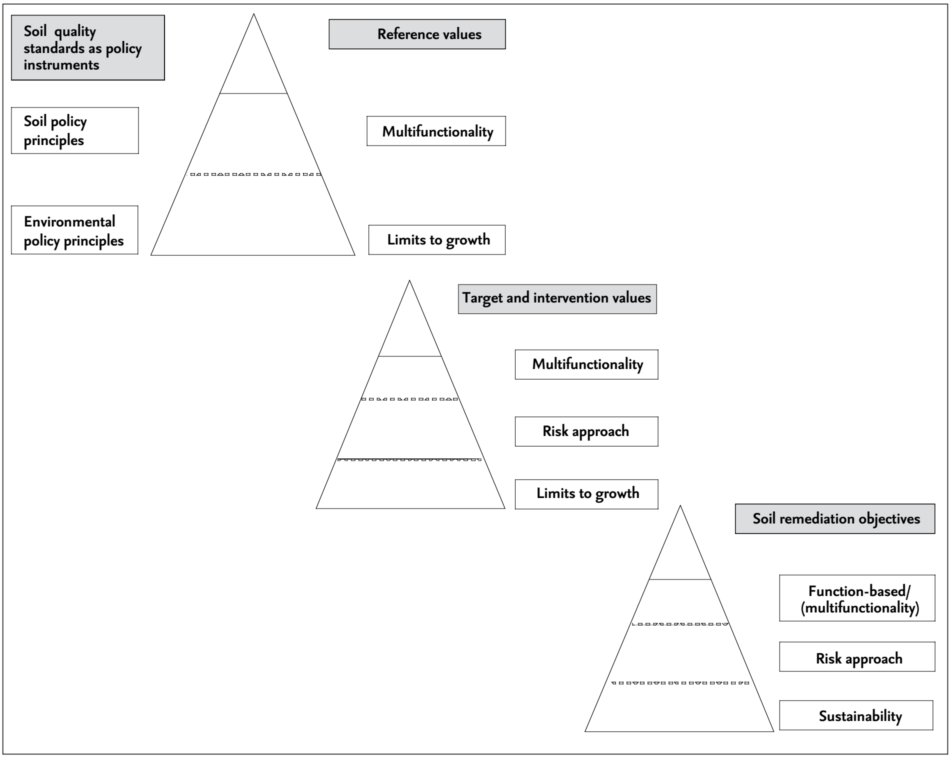


Figure 8.1 Representation of the cognitive dimension for the three successive episodes. Each 'triangle' must be looked at as a representation of an episode. The upper left triangle represents the first episode. In the middle is the second episode and the third episode is on the bottom right. At the bottom of each 'triangle' are environmental policy principles. Towards the top of the triangle, the concepts get more specific for soil policy, and finally for soil quality standards. In the first episode the reference values are developed as standards for soil quality and the principle of multifunctionality is developed. It is specific for soil policy, and used directly as a principle for the development of the reference values. In the second episode, target and intervention values are developed and the risk approach is introduced. This concept has a wider reach compared to multifunctionality, as it pertains to the environmental policy field in general. At the same time it has directed the development of target and intervention values. In the third episode soil remediation objectives have been developed and the function-based approach has been introduced as complementary to multifunctionality. Again, this concept was very specific for soil policy and has directly influenced the development of the soil remediation objectives.

Now that the second row of Table 8.1 (cognitive dimension) is explained in more detail, finally, the normative dimension (the third row from Table 8.1) is explained. This lower row of the table summarises the critical events, achievements and developments in the normative dimension. The three decades could be characterised by three developments.

1 *The development from a sectoral to an integral policy field.*
2 *The decentralisation of soil policy development*
3 *The increased interaction between soil research and policy*

Each of these will be elaborated on. The first is the development from a sectoral to an integral policy field. In the first episode, the development of soil policy was sectoral. Soil, water and air (protection) policies were not integrated and fell under different ministries. Soil protection trailed behind air quality and water quality policy, and had to acquire a position in environmental policy. Typical were the disputes between the Ministry of Public Health and the Environment, and the Ministry of Agriculture and Fisheries about the development of an overarching Soil Protection Act (see Chapter 4, episode 1). In this first episode, this carving out of a (centralised) soil policy was characteristic. In due course, the relations with other environmental policy fields strengthened, illustrated by the joint publication of soil quality standards and water quality standards in 1991 (Min.VROM 1991). Following this, soil was increasingly framed as an economic resource, rather than as an exclusive environmental resource in the third episode. In the description of the second and third episode in Chapter 4, a number of reports and developments were discussed to illustrate this. Actors from the policy fields of physical planning and housing became increasingly involved in soil policy and vice versa.

The second development is the decentralisation of soil policy development. In the first episode, the ministry was the central actor. In the second and third episode the role of the Association of the Provinces of the Netherlands (IPO) and the Association of Netherlands Municipalities (VNG) increased. These government levels were involved in implementation, but now claimed a position in policy development. Their involvement in policy development culminated in the development of 'active soil management'; an approach in which the management of soil as a social and economic resource is professionalised and attuned to the practices in regional and local treatment of soil pollution. In the development of the SROs, both Associations played an important role.

The third development is the increased interaction between soil research and policy. In the first episode, the establishment of the TCSP in the Soil Protection Act was illustrative for the development of scientific knowledge and for the development of the relation between science and policy. The establishment of this committee in the Soil Protection Act caused a reorientation of scientific knowledge for policy about soil quality from a primarily agricultural orientation towards an environmental orientation. This was also reflected in the development of government funded research programmes that could be interpreted as attempts to 'create a coalition of engaged scientists' (see quote in Chapter 4). Secondly, the establishment of this advisory committee embedded the policy field in science. Thereby soil policy came to resemble the policy fields of air and water quality, where scientific advisory bodies had already been established.

This section answered the first research question about the characterisation of the institutional context. Now that the development of the institutional context is characterised, we can get back to the labelling process taking place in regulatory practice. The disciplinary background of the knowledge labelled as usable in the development of the respective soil quality standards is given in Section 8.1.2 in answer to research question 2.

8.1.2 What knowledge is labelled as usable knowledge?

Research question 2 is a factual question into the (disciplinary) background of the scientific knowledge used to calculate the height of the concentration values used for formulating standards.

In the case study about the development of the reference values, the scientific knowledge applied was soil science. More specifically, it was the establishment of relations between chemical and physical soil characteristics and background concentrations of potentially toxic substances. For instance, it was established that for each specific substance it was important to know the concentrations of lutum and organic matter on the site. It was established that these two characteristics of soil determined the (assumed) toxicity of the substance. For instance the binding capacity of the soil determined the availability of this substance for uptake by plants. The knowledge to establish the appropriate formula expressing the relation between chemical composition of the soil and the substance at hand was labelled as usable. Knowledge of the abiotic part of the soil ecosystem was important for the development of the reference values. In the subsequent soil quality standards, the biotic part of the soil ecosystem became more important.

As explained in Chapter 5, this soil science was developed mainly at Wageningen University (then named the Agricultural University). Most of the research at Wageningen University in the 1980s was in support of the agricultural sector. Soils were studied to better understand the uptake of nutrients for crop growth in relation to soil characteristics. The research at Wageningen University dealt with the uptake and role of potentially toxic substances purposely used, for example, in organic manure or artificial fertiliser. Any relation to the presence of substances from other anthropogenic sources went unnoticed, which explains why around 1979 the research project measuring concentration levels of heavy metals carried out at the National Institute for Nature Management (RIN) was presented in the interviews as exceptional and visionary. Such projects were slightly beyond the scope of the institutes conducting such inventories, mainly because they were made in 'relatively undisturbed areas', such as nature reserves. As soil research was oriented towards agricultural practice, inventories in nature areas did not abound, so to speak.

Things changed rapidly after the uncovering of the large polluted sites such as Lekkerkerk. Soil became an issue for further scientific exploration, beyond the scope of agricultural goals, invoking new and large research programmes. The introduction of the principle of multifunctionality also helped to broaden the scope of what was considered relevant scientific knowledge; the ecological function was identified as the most vulnerable one, and therefore as the most restrictive to the determination of soil quality standards. Research into the effects of potentially toxic substances on the biotic part of ecosystems became more important in the second half of the 1980s. Ecologists and ecotoxicologists were recruited as members of the TCSP, who contributed to the development of standards in the second case study. Remarkably, these ecologists and ecotoxicologists were almost exclusively concerned with the effects of substances on soil fauna; research into the effects of potentially toxic substances on plants was restricted to agricultural approaches, with a focus on crop growth and to a lesser extent on the concentration of substances in edible plant parts. Phytotoxicity (toxicity for plants) was a minor field of research, restricted to a small group of researchers at the Amsterdam Free University (prof. W. Ernst). Scientific knowledge labelled as usable knowledge in the second case study was ecotoxicological and pertained to effects of substances on soil fauna.

As explained in Chapter 7, the scientific knowledge in the third case pertained to a mixture of available scientific knowledge to determine the effects of substances on soil and to classify land use. A variety of disciplines now is involved in the development of standards. Approaches from spatial planning concerning the classification of soil were added. Compared to the first case study, a completely new soil classification system was introduced, which was not based on chemical and physical characteristics, but rather on different forms of land use and its requirements. Geography and spatial planning became relevant fields of knowledge for the development of the new framework of standards. The new classification of soil quality, resulting from the introduction of the soil remediation objectives, illustrates that soil had become an economic and societal resource, where it used to be an environmental resource and compartment.

8.1.3 The arguments used for labelling

For the third research question (What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context? (Chapters 5, 6, and 7)), the arguments applied in labelling knowledge in the three cases are brought together in this section.

It was assumed in Chapter 3 that these arguments were related to the institutional context. As was concluded in Section 8.1.1, the first episode was characterised by the concern for the development of the legal framework and for the position of soil policy relative to other environmental fields. In the first case study, I searched for the arguments used in labelling. In part the arguments used in labelling appeared as scientific arguments; the two characteristics used to standardise soil quality (lutum and organic matter) and the appropriate relation between these were subject of intense debate. This debate was spelled out in the TCSP advice on the provisional reference values (VTCB 1986a, 1986b). The argument for labelling the available knowledge as usable knowledge was related to the urgency to proceed with the development of soil policy. The sense of urgency to proceed with the development of soil policy was caused by the ever-increasing number of polluted sites that were being discovered. Scientists and policymakers were concerned with soil quality and were eager to protect soil quality. The concept of multifunctionality provided the cognitive concept that united this effort. Although the meaning of the concept and the appropriateness of the available knowledge to operationalise it was questioned by scientists and by CRMH, it was not a decisive argument against labelling.

As was shown in Chapter 4, Section 4.1, the development of standards was considered an integrated part of a legal framework for soil quality in the first episode. Standards were considered important instruments for the implementation of soil protection as it had been formulated in the Preliminary Soil Policy Plan, awaiting the Soil Protection Act (Min.V&M 1976b; Min.VROM 1983). Based on the research described here, it could be concluded that the labelling of usable knowledge in this first case study was related to the regulative dimension. If we look at this labelling in detail as was done in Chapter 5, it is clear that labelling in this case study was a matter of connecting available knowledge (the Edelman data) to the requirements of a list of concentrations representing clean soil (see Chapter 5). Labelling was not a matter of choosing between different bodies of available knowledge, as was the case in the second and third case study; in this first case study there was simply no alternative approach available.

In the second case study, there were several instances of labelling. A major labelling process took place when the Health Council assessed a number of approaches and labelled the Kooijman approach as the best because it was most accurate. However, this advice was not followed as it turned out that the results obtained by Kooijman were difficult to implement, and so the models by Van

Straalen and Denneman, that were based on assumptions and basic work by Kooijman were used to calculate concentration levels. The coherence of policy concepts and scientific concepts became important. Knowledge was usable if it facilitated the development of a concept based on both a policy and a scientific concept. The arguments used in labelling were in part cognitive, as there was intense debate about risk levels and the adequacy of using the composition of species as an indicator of ecosystem functioning. Arguments were related to the cognitive dimension. In addition, as was argued in Chapter 6, there is an argument that is related to the normative dimension. The authors of the Van Straalen approach tried to match scientific recognition with recognition from policy for the developed approach, whereas the author of the Kooijman method posed that policy recognition was subordinate. This concerns the relation between science and policy and is one of the characteristics of the difference between regulatory science and research science and has played a role in the labelling of the Van Straalen method.

In the third case study, the development of soil remediation objectives (see Chapter 7), it is remarkable that limited time was granted to develop a scientific approach. The production of new standards was part of a more encompassing project on policy renewal. Its credo was that the standards had to be shared by the participants, i.e., the Association of Provinces of the Netherlands (IPO), the Association of Netherlands Municipalities (VNG) and the Ministries of Public Housing, Spatial Planning and the Environment, the Ministry of Agriculture, Nature and Fisheries, and the Ministry of Infrastructure and Waterworks. The credo of shared standards led to the development of a set of standards that reflected the contribution of all these participants. The labelling of usable knowledge concerned selecting available knowledge and evaluating its usefulness to the development of a set of standards. In this episode, renewals took place in the normative dimension. The decentralisation of the development of environmental policy became the prime issue as it was crucial to the new set of standards to facilitate these normative renewals. The labelling of usable knowledge was legitimised also by its match with this development in the normative dimension. In addition, in the third case study, an argument related to the cognitive dimension played an important role. The framing of soil as an environmental compartment worthwhile to be protected was reframed. In this new frame or perspective, soil became an economic and social resource.

From the comparison of the three case studies, it is clear that the arguments for labelling were increasingly connected to the normative dimension. The cognitive dimension always played a major role in the argumentation, although there are some doubts about this with respect to the third case. In the third case, the arguments were framed as relating to the cognitive dimension (function-based quality), but the way the argumentation was built suggests that this concept was developed to facilitate the shift from central and environment-oriented policy towards de-central and spatial planning-oriented soil policy, which obviously is an argument related to the normative dimension. In Section 4.3.2 this argumentation is explained in detail.

In each of the case studies, arguments were given for labelling that could be connected to the scientific quality of the work. For instance, in the case of reference values it was seriously doubted by scientists from Wageningen University whether the number of samples collected and analysed sufficed and whether the statistical techniques applied by the ministry's staff members were adequate to develop these standards. In the second case study, scientific arguments were also used by the Health Council. However, as shown in Chapter 6, these were not decisive. In none of the cases, these (scientific) arguments were brought to the fore as the main, decisive, and convincing arguments.

8.1.4 Development of regulatory practice

This thesis uncovered the development of regulatory practice by comparing three case studies from the same policy field. Research questions 1, 2, and 3 focused on the relation between regulatory practice and institutional context and on the disciplinary background of usable knowledge. The research questions guided the research described in Chapters 4, 5, 6 and 7, and the answers to those research questions are informative about the development of regulatory practice. A complete and overall analysis of all aspects of regulatory practice was not the stated aim of this thesis. An overall analysis of regulatory practice would have to include an analysis of the actors involved in maintaining regulatory practice (to mention a few: task groups of the Health Council, steering groups and advisory committees of research programmes, etc.). Rather, the focus in this thesis was on one important proces in regulatory practice: the labelling of usable knowledge.

In the interpretative framework two different perspectives on the relation between science and policy in regulatory issues were discussed. The first is to perceive the development of standards, and more specifically, the labelling of usable knowledge as boundary work between science and policy. From such a perspective, it is logical to focus on the demarcation and blurring of the boundary between science and policy. The second perspective was an institutional perspective. In that perspective, standard setting is regarded as a process taking place within regulatory practice embedded in an institutional context. The arguments for labelling usable knowledge are not evaluated as devices to blur or demarcate the boundaries between science and policy, but rather as devices to anchor regulatory practice to an institutional context. As a means to structure the discussion here, Figure 8.2 is repeated from Chapters 1 and 3.

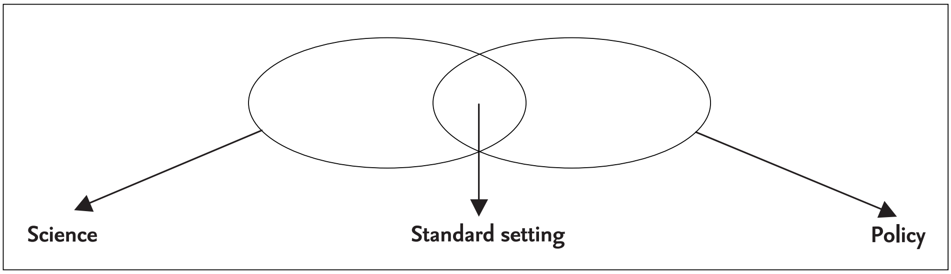


Figure 8.2 Standard setting at the overlap of science and policy

Figure 8.2 illustrates that science and policy are connected to each other. Although this may sound trivial, it is not from a historical perspective. This connection was actively established in the first episode. Before then soil policy as such was inexistent and soil science, with its focus on nutrient and fertiliser, crop growth and production, had a different focus. In the first episode, science and policy concerned with soil quality began to develop relations beyond an informal status, and the intense interactions between science and policy revealed that they both claimed a position in the labelling of usable knowledge. Boundary work appears in this case as boundary blurring; the boundary between science and policy partly disintegrates. From that perspective, the establishment of the PTCSP was a landmark in that episode. In the second episode regulatory science and research science were demarcated. The comparison of different scientific methods followed by labelling one of them as usable. Through this comparison of existent methods, the labelling process resulted in the active demarcation between regulatory science and research science. In Figure 8.2, this demarcation is illustrated by the dotted line at the left part of the overlapping area. In the third episode, the boundary between (regulatory) science and policy was subject of intense debate between the RIVM and Core team A. This debate refers to the dotted line at the right part of the overlapping area.

What was left untouched in this research was whether boundary work occurred in the policy domain, i.e., was there any demarcation or blurring taking place within policy distinguishing regulatory policy issues from other policy issues. From this perspective boundary work in the three respective cases manifested itself as boundary blurring and as boundary demarcation.

The research described here focused on the *development* of standards. In doing so, the *implementation* of standards was forced to the edges of the scope of this thesis. By focusing on science and policy, other actors (industry, consumers, consultancies, companies, media) where forced to the edges of the scope as well. This restriction was productive for the most part, but became somewhat more problematic in the analysis of the third case, where the development of new standards was determined to a large extent by the actors involved in the implementation of the standards, i.e., industry and the local authorieties. A case study conducted within the framework of this thesis research by an MSc student on the development of the concept of added risk (Van Langen 2001) made it clear that industry and private parties were claiming a position at the table of standard setting. Future studies into the development of standards should broaden up the perspective and include development as well as implementation of standards more explicitly.

8.2 Labelling usable knowledge for soil quality standards in the Netherlands

Now that the research questions have been treated and answered in Section 8.1, the guiding question remains to be answered. In Chapter 1 the guiding question was formulated as repeated here:

> *How can we understand the labelling of usable knowledge for the development of soil quality standards in terms of boundary work between science and policy and in terms of the relation between regulatory practice and its institutional context?*

The answer to this guiding question is not straightforward, which is why I come back to the perspectives explained in Chapter 1 to have guided the research described in this thesis. In Chapter 1, it was explained that standards were perceived in this thesis as instruments between science and policy. In Section 1.3, it was argued that the representation of the development of standards involving scheduled interaction between the separable domains of science and policy was inappropriate. The assumption that science and policy are separate domains in the development of soil quality standards is problematic, and because of that, the idea of a scheduled interaction is inappropriate. The domains of science and policy cannot be distinguished unambiguously as was shown by the analyses of the cases and the context in this thesis. The perception that the responsibilities and tasks of science and policy are clear is not supported by the research described in this thesis. Moreover, the case studies reveal the opposite: the tasks and responsibilities are situation-specific and negotiated in every specific case. Examples from each of the case studies in support of this claim are given. In the first case study, policymakers at the Ministry of Public Health and the Environment used scientific knowledge they had gained themselves to write a first proposal for the reference values. It could be argued that the sense of urgency at that moment legitimated the policymakers to publish a list with provisional reference values. In a strict distinction of tasks and responsibilities between science and policy, however, it would have to be the scientists who drew up a first proposal for concentration levels indicating clean soil. In practice this distinction between tasks and responsibilities was clearly and actively blurred. As an example from the second case study, scientists developing the Van Straalen method to establish Maximum Tolerable Risk levels argued that their scientific method would help to further soil policy. In fact, this was their motivation for the development of the method, which they would not have in a strict distinction of tasks and responsibilities. As an example from the third case study, the distinction between science and policy was unclear; the tasks and responsibilities for the land use typology, developed in that case study, shifted back and forth between the National Institute for Public Health and the Environment and the Ministry of Public Housing, Spatial Planning and the Environment. The tasks were not clear beforehand, but developed in due course. These examples support the claim that the assumed distinction between tasks and responsibilities of science and policy is misleading and inadequate to further the understanding of the development of soil quality standards. As a final example that is not specifically related to one of the case studies, the results of a survey held at the National Symposium Bodembreed are revealing (Souren 2000; Souren, Poppen et al. 2000). First, most of the respondents (visitors of the Annual Symposium) were affiliated to policy and research organisations either at the same time, or had changed job positions in the recent past between typical research and policy organisations. This information about professional careers reveals that it is inappropriate and probably also unproductive to differentiate between scientists and policymakers as two distinct professional careers. Second, except for the universities and the Ministry of Public Housing, Spatial Planning and the Environment, no other organisation actively involved in the development of soil quality standards was perceived by the participants as an organisation exclusively producing scientific knowledge or exclusively as a policy-making organisation. Organisations involved in soil policy were typified at intermediate positions; somewhere between science and policy. They did not fall into either of the two categories. The results of the case studies call for an alternative representation of the development of standards. In this alternative conception it should be acknowledged that the development of standards takes place in a regulatory practice where different interests are weighed and negotiated per situation. This allows for more effective evaluations and reflections on the course and future direction of soil policy, environmental policy and the use of quality standards as policy instruments. A representation of actual practice would also reveal that standards are not only the outcome of social processes, but also the determinants of social processes. Standards for soil quality also determine the playground for all parties with an interest in soil quality, ranging from scientists, to policymakers, to industry, to home-owners, and other parties. For instance, the height of the standards determines clean-up costs and the exact location of housing and construction projects. This reorientation acknowledges the performative role of standards; that they indeed set the playground and are the determinants of social processes. Recognising that the development of standards for soil quality takes place in a regulatory practice is expected to enrich and inspire the further development of environmental quality standards. It opens up various possibilities to discuss and debate how to deal with uncertainties as they are produced and perceived by different parties.

The second aspect of the answer to the guiding question is a reflection on the concealment of the production process of standards behind the quantitative formulation of these standards (Section 1.2). Whereas this quantitative representation suggests that standards for soil quality represent scientific certainty and consensus, the analysis of the labelling of usable knowledge made in this thesis has produced substantial 'contradictory evidence'. From all three cases, serious doubts can be raised about the scientific underpinning of the concentration levels that are used to quantify policy objectives. The question can be raised why these standards are formulated as concentration levels anyway. What is the relevance of distinguishing soil with a copper concentration of 35 mg/kg dry soil from soil with a copper concentration of 37 mg/kg dry soil, especially if the uncertainties associated with the production of that concentration level are not explained and communicated? The representation of standards as concentration levels thus suggests scientific certainty and consensus. On the basis of the research described in this thesis this assumption must be contested at the very least. To add further weight to the answer, the analyses of the cases in this thesis showed that the concentration levels are calculated in models and approaches that have been selected based on arguments related to the institutional context of soil policy and research. The quantitative representation conceals this background. The arguments used in labelling and the political choices they represent, disappear behind the concentration level. As it is, these arguments, through their relation to the dimensions of the institutional context are much more informative about the course of soil policy than the listings of concentration levels as such. From the analysis of the case studies, it was observed that arguments related to the normative dimension have become more important. This is to say that the quality standards have become instruments in facilitating the complex interactions and interests of parties involved in issues of soil quality. This background is concealed behind the listing of concentrations for substances. It is essential information for those actors participating in the further development of soil policy and quality standards. The framework of soil quality standards has become prohibitively complex and is beyond the understanding of many actors and the public.

In addition, a significant body of research has been accumulating over the past years about the various problems associated with quantitative representation of what is known to be fraught with scientific dissent and uncertainty (Hoffmann-Riem and Wynne 2002; Klinke and Renn 2002; Walker et al 2003). In addition to the two issues above (scientific dissent and uncertainty, and the political choices made in the development process), trust in scientific expertise is at stake, and trust, after all, is expected to benefit from a more open and reflexive attitude.

8.3 Reflection on methodological and theoretical choices

An interpretative approach opens up black boxes, not just for the sake of opening up (although it is rewarding as such at times), but for the sake of understanding. The box of labelling usable knowledge for soil quality standards was opened up in this thesis. That was done by developing and applying an interpretative framework to three case studies and their context. In the interpretative framework, boundary work was taken as the initial perspective. The concept has been used by several researchers in analyses of the relation between science and policy (Halfmann 2000; Jasanoff 1990) and in analyses of standards and indicators (Bal 1998; Turnhout 2003). Based on an argumentation given in full in Chapter 3 and not repeated here, the concept of institutional context was added to the interpretative framework as a means to further understanding. What this approach has added to our insight is that the arguments used in the labelling of usable knowledge relate to the context within which these standards are developed and implemented. With the development of this context, the argumentation changes.

The resulting interpretative framework also facilitated the comparison of cases and context. The wider context within which standards for soil quality were developed and implemented was analysed and described in terms of the three dimensions (cognitive, normative and regulative) and in each of the case studies the arguments used in labelling could be evaluated for their relation to the institutional context. In doing so a methodology for contextual analysis was developed.

Besides pointing out the advantages of applying the institutional perspective in addition to the boundary work metaphor, it is important to discuss a drawback of the concept of institutional context as developed by Scott. Analytically distinguishing between normative, cognitive and regulatory dimensions in policy fields suggests that distinctions can indeed be observed. This is not true, because it is the analyst who differentiates between these dimensions and who sorts the empirical material. The advantage of an essentialist approach like this one, is that it helps to understand and interpret the relation between regulatory practice and institutional context, which is part of the guiding question of this thesis. Additional research would have to focus on the interplay of the dimensions. Wherever I felt it was clear and appropriate to do so, I pointed at instances where aspects of these dimensions interacted. For instance replacing the principle of multifunctionality by a function-oriented approach as discussed in Chapters 4 and 7, was not exclusively about a change in the cognitive dimension. Rather, both concepts were paralleled by developments on the normative dimension. For instance, the definition of the principle of multifunctionality gives no indication whatsoever that national government has primacy over provincial or municipal government. The concepts have become symbols referring also to the relations between science and policy and to the relations between national and sub-national governments, more than to soil quality. These difficulties in sorting out the empirical material are typical for essentialist approaches. Such approaches are prone to criticism. Although criticised by many, essentialist typologies abound. A good essentialist typology forces the researcher to be explicit about the arguments to sort out the empirical material into the typology. As I see it, the concept of institutional context as developed by Scott does not yet qualify as a 'good essentialist typology'. As discussed in Chapter 3, the definition of the three dimensions is not fully fledged, leaving too much degrees of freedom for any researcher to sort out the empirical material.

An issue that should be explored further in the future is the consistency of the two perspectives (boundary work and institutional context) with respect to their epistemological assumptions. In general, institutional concepts assume a tension between dynamics and stability. For instance, applying the concept of institutional context forced me to search for patterns, stabilisations. That worked well, as long as I did not get into the details of the development of standards for soil quality. As soon as I did that, the assumed stability (sedimented regulatory practice) dissolved. The boundary work perspective is almost the exact opposite: the name alone reveals a focus on action, on activity, and on change. From a boundary work perspective, stability is an illusion. This tension between dynamics and stability was solved by explaining the relation between the case studies and the context. In the context chapter I searched for relatively stable patterns, while the case study allowed uncovering daily work. In doing so, I managed to keep the tension between the different epistemological perspectives within limits, and even use this epistemological difference as a means to increase insight and understanding of both the cases and the context.

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Appendix

Informants and respondents interviewed between 1998 and 2003

Informants

Prof.dr. F.A.M. de Haan	Wageningen University
Prof.dr. P. de Ruiter	SKB
Prof.dr. H.J.P. Eijsackers	Alterra
Dr. J. Faber	Alterra
Dr. J. Hermens	Utrecht University
Mrs. drs. M. Klein	IKC Wageningen
Mrs. dr. Ch. Klok	Alterra
Prof.dr J. Koeman	Wageningen University
Drs. S. Ouboter	NOK
Mrs. dr. J. van Wensem	TCSP

Respondents

Mrs. dr. S. Boekhold	VROM	March 5, 2002
Drs. N. de Wit	VROM	October 24, 2002
Drs. Th. Edelman	Wageningen University	April 5, 2000
Prof. dr. H.J.P. Eijsackers	Alterra	March 5, 2002
Prof. dr. S.A.L.M. Kooijman	Free University	February 21, 2002
Dr. Th. Lexmond	Wageningen University	April 6, 2000
Drs. J.E.T. Moen	Consultancy	July 31, 2000
Dr. J. Lijzen	RIVM	January 21, 2003
Prof. dr. W.C.Reij (retired)	Voorschoten	June, 24, 2002
Prof. dr. N.M. van Straalen	Free University	March 27, 2002
Dr. J. Vegter	TCSP	May 2, 2000
Ir. D. Zeilmaker (retired)	Harlingen	October 9, 2001

Summary

Standards, soil, science and policy

Labelling usable knowledge for soil quality standards in the Netherlands 1971-2000

Standards for soil quality distinguish between ‘polluted soil’ and ‘clean soil’. That distinction is formulated as a concentration level specific for a substance. For example, the soil quality standard for copper published in 1988, stated that standard soil (soil with a specific lutum and organic matter content) with a copper concentration of 35 mg per kg dry soil, or lower, is classified as ‘clean’, whereas soil with a copper concentration of 36 mg per kg dry soil or higher is classified as ‘polluted’. For most substances such concentration levels have been derived over the years. Classifying a soil as polluted, has far reaching implications. For instance, sites that are classified as ‘polluted’ have to be cleaned-up. Clean-up treatments are often time consuming and expensive. Well known examples in the recent history of Dutch soil policy are the extensive treatment projects at the Volgermeerpolder, the Utrecht Griftpark and a residential area in Lekkerkerk. Because of the far reaching implications, the exact level of the standards is of interest to all parties involved. Not surprisingly, these different parties want to have a say in the development of the standards. Traditionally, science and policy dominated this development, but more recently other parties like industry, and local and regional authorities have become increasingly important. The scientific underpinning of standards is still considered crucial, but the number of stakeholders involved made the process of standard development more complicated (and more interesting).

Soil quality standards: between science and policy

The development of standards for soil quality in the Netherlands between 1971 and 2000 is the broad subject of this thesis. More specifically, it is the process of selection of specific scientific models and approaches to calculate the concentration levels that is analysed in this thesis. Soil quality standards have been developed in Dutch policy since the early 1980s. In 1982 the first standards, the so-called ABC values, were published. Since then soil quality standards have been updated regularly. Sometimes updates stemmed from new scientific insights, but mostly it were

policy developments that were the main drivers for the formulation of a new set of standards. In 1988, 1991/1994 and 1999, the ABC values were succeeded by the reference values, target/intervention values, and soil remediation objectives respectively. Changes in the height of the standards or in the policy measures following standard violation can cause great confusion, and maybe even generate distrust in the standards and the standardsetting process. However, changes can also be perceived as a relief. For instance when parties agree that standards are too strict, relaxation of the standards is welcomed. For standards to be trusted and accepted among involved parties they have to be tuned to the context in which they are used and developed. Standards must not only be scientifically underpinned, but they must also fit in the context of the involved parties and their interests.

This broader context is concealed when standards are viewed only as substance specific concentration levels. The research project described in this thesis, aims to remove this concealment. At least a part of it is unveiled by looking at the process of how knowledge is labelled as usable to derive concentration levels. In this process science and policy are both involved.

Having said this, a qualification is in place. The mere suggestion that science and policy could be distinguished as distinct parties in the development of standards has been criticised repeatedly. The practice of standards' development is more accurately represented as a process in which science and policy meet and merge, up to a level where they cannot be distinguished unambiguously. For instance, representatives from the responsible ministries and staff from research institutes are both involved. In most cases these people have an academic background in a relevant discipline. The arguments used in labelling knowledge as usable contain scientific, as well as policy, arguments and interests. In this thesis these arguments are traced down and analysed with the help of an interpretative framework that will be explained below. Before moving on to this explanation one more characteristic of standards must be mentioned.

So far, standards have been framed to represent a physical quality, the concentration level of a substance in the soil. However, its implications are of a socially constructed nature: what is clean or polluted is not a physical quality itself; it is a value judgment and the outcome of a social process. The hybrid character makes standards an interesting object of study. To understand the hybrid character of standards one needs to be familiar with both the physical and social aspects of standards. This thesis represents an interdisciplinary study that draws attention to and exposes the hybrid character of soil quality standards.

As argued above, science and policy are both involved in the production of standards; each with its own perspective, but with the common interest to develop standards. In this thesis the joint involvement of science and policy is characterised as 'regulatory practice'. One of the processes ongoing in regulatory practice is the labelling of usable knowledge to calculate concentration levels that eventually get the status of standards for soil quality. What models are used to calculate these levels? What approaches are adequate to decide whether adverse effects of the presence of substances in soil are acceptable? These questions are essential in environmental policy and management.

Research approach: two concepts

Given the widespread use of standards and their far reaching impact, it is interesting and relevant to understand the knowledge labelling process in regulatory practices. There are several possible approaches to achieve this aim. In this thesis it was assumed that the arguments used for the labelling of usable knowledge are indeed related to the context within these standards for soil quality are embedded: the context of soil policy. As was mentioned above, for standards to be trusted and accepted, they have to be tuned to the context within which they are used and developed. The main concepts used in this research to analyse the development of standards are 'boundary work', as coined by T.F. Gieryn in 1983, and 'institutional context', proposed by W.R. Scott since 1995.

The first concept, boundary work, refers to the interaction between science and policy in which the boundary between the two domains is at stake. Boundaries between science and policy can be blurred, (re)produced, penetrated, crossed, etcetera. I looked at the labelling of usable knowledge from that perspective. The differences or similarity between science and policy is central to such a perspective. The concept of boundary work is attractive when describing processes related to the utilisation of scientific knowledge in policy and regulatory issues, and it has been widely used for that purpose. However, I found that the concept had insufficient analytical strength for the purpose of this thesis. The application of an institutional perspective, complementary to boundary work, was found to enhance understanding of the processes studied in this thesis. This is reflected in the guiding question mentioned below, in which both concepts (boundary work and institutional context) are included. The concept of institutional context makes explicit and operational that institutions are multidimensional; a regulative, normative and cognitive dimension are distinguished. The regulative dimension is characterised with the indicators rules, laws and sanctions. It has expedience as its basis of compliance and coercive mechanisms. Applied to the labelling of usable knowledge, arguments based on references to legal frameworks would qualify as regulative. The normative dimension defines goals or objectives (e.g. winning the game, making a profit) but also designates appropriate ways to pursue them (e.g. rules specifying how the game is to be played, conceptions of fair business practice). Some values and norms apply to all actors involved, whereas others apply only to certain types of actors or positions. The latter gives rise to roles: conceptions of appropriate goals and activities for particular individuals or specified social positions. The cognitive dimension refers to shared conceptions that constitute the nature of social reality and the frames through which meaning is generated.

Central question

The guiding question of this thesis includes both concepts as complementary perspectives for the understanding of labelling usable knowledge:

How can we understand the labelling of usable knowledge for the development of soil quality standards in terms of boundary work between science and policy and in terms of the relation between regulatory practice and its institutional context?

The guiding question is broken down in five separate research questions. These questions are addressed in the empirical chapters that are at the heart of the thesis.

1. *How can the institutional context be characterised? (Chapter 4)*
2. *What knowledge is labelled as usable knowledge? (Chapters 5, 6, 7)*
3. *What are the arguments applied in labelling and how do they relate to the dimensions of the institutional context? (Chapters 5, 6, 7)*
4. *How does regulatory practice develop during the research period? (Chapter 8)*
5. *How do the dimensions of the institutional context affect the labelling of usable knowledge in regulatory practice? (Chapter 8)*

The three dimensions were used to describe the context of soil policy and the development of scientific knowledge (Chapter 4). Writing a concise history of a policy field and the development of scientific knowledge is prone to criticism from insiders as such overviews are never exhaustive. The aim was to provide an interpretation of recent history for the purpose of my study: to better understand the arguments that are used in labelling usable knowledge for soil quality standards and to understand how regulatory practice and institutional context are linked. A second and more critical issue could be brought up, concerning the method applied to analyse and describe the institutional context. I sorted out all material by using the three dimensions as described above. While doing so, it became clear that several events, achievements and developments could be assigned to more than one dimension. It must be noted that it cannot be objectively established whether a particular event, achievement or development should be classified as cognitive, normative or regulative. For instance, cognitive concepts (cognitive dimension) are developed through interaction between actors (normative dimension). As it is, the cognitive and normative dimensions are closely related. The same holds for the regulative and normative dimension. Acts and rules (regulative dimension) are developed and maintained in the interaction between actors (normative dimension). Because of this interrelatedness, the cognitive, normative and regulative dimensions cannot be distinguished unambiguously. The rationale for the distinction made during this research was that events, achievements and developments that were mentioned or used in interviews and documents as important for the relations between different actors, were grouped as normative. Other events, achievements and developments were interpreted either as regulative or cognitive. The context was subdivided into three episodes and each episode was characterised by identifying regulative, cognitive and normative events, achievements and developments.

	Episode 1; 1971-1988	Episode 2; 1989-1994	Episode 3; 1995-2000
Regulative	• Interim Soil Pollution Act (1983) • Soil Protection Act (1987)	• Integration of Interim Soil Pollution Act and Soil Protection Act (1994)	• Revision Soil Protection Act (1994) • Cabinet's position (1997) • Building Materials Decree (1999)
Cognitive	• Multifunctionality	• Risk approach • Multifunctionality	• Function-based quality • Risk approach • Multifunctionality
Normative	• Carving out a department (sector) for soil quality at the Ministry of Public Health and the Environment • Disputes between ministries over authority to regulate soil quality • Establishing the Technical Committee on Soil Protection • Soil research programmes (Soil Protection, Soil Ecology, Netherlands Integrated Soil Research Programme SPBO)	• Active soil management • Increase in number of actors involved in policy development (notably the VNG, the IPO) • Integration of environmental policy fields • Criticism with regard to abstract and insufficiently operational principles guiding soil policy • Soil research programme (Netherlands Integrated Soil Research Programme SPBO)	• Active soil management • Soil policy renewal: BEVER, six aspects from Target Perspective • Soil research programmes (PGBO, NOBIS, SKB)

The case studies described in this thesis are embedded within the context of a series of episodes. The first episode (1971 -1988) contains a case study on the labelling of usable knowledge for the reference values. The second episode starts in 1989 and ends in 1994. In this second episode, the second case study pertaining to labelling of usable knowledge for target and intervention values is embedded. The third and last episode starts in 1995 and ends in 2000. The third case study is embedded in this episode and pertains to the labelling of usable knowledge for soil remediation objectives.

In each of the three case studies, I searched for the arguments that were used in labelling and considered the connections between these arguments and the dimensions of the institutional context. In fact by doing so, it revealed the connection between the processes ongoing in the case study (labelling of usable knowledge in regulatory practice) and the institutional context that each of the case studies was embedded in. For each of the case studies that link was clarified, and in addition the differences in the arguments for the labelling of usable knowledge between the three case studies could be highlighted.

Case study results

In the first case study I analysed the labelling of usable knowledge for the development of reference values for heavy metals. Labelling in that case was a matter of justifying the adequacy of available knowledge to calculate reference values, thereby satisfying the need for standards. Policymakers and scientists were concerned with the slow progress of soil policy and the lack of adequate soil quality standards to further policy development. In fact, the guiding principle for soil policy had been formulated, but an operationalisation of it was still lacking. The reference values were meant to do just that. This guiding principle; multifunctionality, stated that the quality of soil had to be such that it qualified for all land uses. It was assumed that soil quality in relatively undisturbed areas met that criterion and consequently, the concentrations of heavy metals in those areas were used to calculate these reference values.

In the second case study, results of experimental studies measuring the effects of substances on specific soil organisms, were used to calculate the new soil quality standards. The scientific knowledge that was labelled as usable was experimental ecotoxicological knowledge. Compared to the previous case, the importance of eco(toxico)logical knowledge relative to soil science had increased. That knowledge was tuned with the development of the risk approach in Dutch environmental policy. The risk approach was introduced in Dutch environmental policy in 1989. In soil policy, the risk approach complemented the principle of multifunctionality.

In the third case study, the situation had changed. The principle of multifunctionality that had been central to soil policy was abandoned when evaluating polluted sites. It was replaced by the principle of function-based quality. This principle implied that soil quality criteria had to be derived for different land uses. These soil quality criteria (soil remediation objectives) were developed within a policy renewal project (BEVER). This policy renewal aimed at decentralisation and at the increase of a participatory approach in soil policy. The development of the soil remediation objectives was analysed in the third case study. The knowledge that was labelled as usable had been developed and applied before for other soil quality criteria that where used in a different context (agriculture, spatial planning).

Labelling usable knowledge: an integration

The study described in this thesis revealed that the arguments that are used for the labelling of usable knowledge for soil quality standards were related to the institutional context of soil policy and the development of scientific knowledge on soil quality. In the first case the progress of soil policy, especially the implementation of the Soil Protection Act, provided a crucial argument in the labelling process. That is to say that the regulative dimension played an important role in the labelling of usable knowledge. For the second case study it could be argued that the cognitive dimension became most important. The risk approach had been formulated in close cooperation with scientists and it stated that minimum risk levels for environmental compartments were inevitable and that they had to be identified at concentration levels below which 95% of the species in an ecosystem were not exposed above an adverse concentration level. Specific models, based on experimental ecotoxicological knowledge were applied to estimate these levels. Finally, in the third case study, standards had to be developed to facilitate a renewal in soil policy that focused on decentralisation, involvement of stakeholders and integration with other policy fields. The involvement of different actors, interests and approaches was reflected in the knowledge that was used to develop the soil remediation objectives. This knowledge was developed and used by different actors and was applied in agricultural and spatial planning policy.

The representation of standards as concentration levels suggests scientific certainty and consensus. On the basis of the research described in this thesis this assumption must be contested at the very least. The analyses of the cases in this thesis showed that the concentration levels are calculated in models and approaches that have been selected based on arguments related to the institutional context of both soil policy and research. This adds further weight against the above assumption. The arguments used in labelling and the political choices they represent, are concealed behind the concentration level. As it is, these arguments, through their relation to the dimensions of the institutional context are much more informative about the course of soil policy than the listings of concentration levels as such. From the analysis of the case studies, it was observed that arguments related to the normative dimension have become more important over the years. This is to say that quality standards have become instruments to facilitate the complex interactions and interests of parties involved in issues of soil quality. This background is essential information for actors participating in the further development of soil policy and quality standards. The framework of soil quality standards has become very complex and is beyond the understanding of many actors and the public.

In addition, a significant body of research has been accumulating over the past years about the various problems associated with quantitative representation of what is known to be fraught with scientific dissent and uncertainty. In addition to the two issues above (scientific dissent and uncertainty, and the political choices made in the development process), trust in scientific expertise is at stake, and is expected to benefit from a more open and reflexive attitude.

Reflection on interpretative framework

In the last chapter of the thesis a reflection on the approach and theoretical choices is given. An interpretative approach opens up black boxes. That was done in this thesis by developing and applying an interpretative framework to three cases and their context. In the interpretative framework, boundary work was taken as the initial perspective. The concept has been used by several researchers in analyses of the relation between science and policy. Besides pointing out the advantages of applying the institutional perspective in addition to the boundary work metaphor, it is important to mention a drawback of the concept of institutional context as developed by Scott and applied in this thesis. Analytically distinguishing between normative, cognitive and regulatory dimensions in policy fields suggests that distinctions can indeed be observed. This is not true, because it is the analyst who differentiates between these dimensions and who sorts the empirical material. The advantage of an essentialist approach like this one, is that it helps to understand and interpret the relation between regulatory practice and institutional context, which is part of the guiding question of this thesis. Additional research would have to focus on the interplay between the dimensions. These difficulties in sorting out the empirical material, are typical for essentialist approaches. Although criticised by many, essentialist typologies dominate the scientific field. A good essentialist typology forces the researcher to be explicit about the arguments to sort out the empirical material into the typology. As I see it, the concept of institutional context as developed by Scott does not yet qualify as a 'good essentialist typology'. As discussed in Chapter 3, the definition of the three dimensions is not full-fledged, leaving too many degrees of freedom for any researcher to sort out the empirical material. A second and related issue that should be explored further in the future is the consistency of the two perspectives (boundary work and institutional context) with respect to their epistemological assumptions. In general, institutional concepts assume a tension between dynamics and stability. For instance, applying the concept of institutional context forced me to search for patterns and stabilisation. That worked well, as long as I did not get into the details of the development of standards for soil quality. As soon as that happened, the assumed stability (crystallized regulatory practice) dissolved. The boundary work perspective is almost opposite: the name alone reveals a focus on action, activity and change. From a boundary work perspective, stability is an illusion. In this thesis, the tension between dynamics and stability was solved by explaining the relation between the case studies and the context. In the context chapter relatively stable patterns were searched for, while the case study allowed uncovering daily work. In doing so, I managed to keep the tension between the different epistemological perspectives within limits, and even use this epistemological difference as a means to increase insight and understanding of both the cases and the context.

Samenvatting

Normen, bodem, wetenschap en beleid

De selectie van bruikbare kennis voor de afleiding van bodemkwaliteitsnormen in Nederland 1971-2000

Bodemkwaliteitsnormen zijn beleidsinstrumenten waarmee het onderscheid tussen 'schone bodem' en 'verontreinigde bodem' wordt gemaakt. Dat onderscheid wordt gemaakt op basis van de aanwezigheid van stoffen in de bodem en is voor elke stof afzonderlijk vastgesteld. Zo is de bodemkwaliteitsnorm voor koper in 1988 vastgesteld op 35 mg per kg droge standaardgrond (dat is grond met een vastgestelde samenstelling van lutum en organische stof). De betekenis van die norm is dat bodem waarin 35 mg of minder koper per kg grond wordt gemeten, als 'schoon' wordt aangemerkt. Bodem waarin concentraties van 36 of meer mg per kg grond wordt gemeten wordt als 'verontreinigd' aangemerkt. Wanneer op een lokatie de norm wordt overschreden moeten er binnen een bepaalde termijn maatregelen genomen worden. De lokatie moet gesaneerd worden, of de verontreiniging wordt geïsoleerd, beheerst en gecontroleerd (IBC maatregelen). Bodemsaneringen zijn vaak duur en omvangrijk, en daarmee ingrijpend. Bekende voorbeelden van lokaties waar ingrijpende saneringen zijn uitgevoerd zijn de Volgermeerpolder, het Griftpark in Utrecht en de woonwijk Lekkerkerk bij Gouda. Het kan nogal wat uitmaken hoe hoog die norm precies is; het kan het verschil zijn tussen wel of niet saneren. Hoe wordt de hoogte van die norm eigenlijk bepaald?

In dit proefschrift staat de afleiding van die bodemkwaliteitsnormen in Nederland tussen 1971 en 2000 centraal. Meer precies is het proces onderzocht waarin wordt vastgesteld welke wetenschappelijke kennis wordt gebruikt voor het afleiden van die stofconcentraties.

Normen voor bodemkwaliteit: tussen beleid en wetenschap

Normen als beleidsinstrumenten zijn in het Nederlandse milieubeleid sinds de jaren zeventig populair. In de jaren zeventig en tachtig was de vaststelling van de hoogte van de norm een aangelegenheid van (nationaal) beleid en wetenschap. De industrie, het bedrijfsleven, de regionale en lokale overheden en de maatschappelijke organisaties speelden nauwelijks een rol van betekenis. In de jaren negentig kwam hierin verandering. De invloed van de genoemde partijen op de afleiding van normen nam toe. Onverminderd deze toename van het aantal en van de diversiteit van de actoren, bleef de waarde die werd gehecht aan de wetenschappelijke onderbouwing van de bodemkwaliteitsnormen.

De eerste bodemkwaliteitsnormen, de ABC waarden, werden in 1982 afgeleid, en gepubliceerd in de Interimwet Bodemsanering. Sindsdien zijn er nog twee normenstelsels ontwikkeld. Doorgaans waren het ontwikkelingen in het beleid die de aanleiding vormden voor vernieuwing van de normen. Die vernieuwing leidde achtereenvolgens tot de vaststelling van de referentiewaarden in 1988, de streef- en interventiewaarden in 1991/1994 en de vaststelling van de bodemgebruikswaarden in 1999. Steeds was de aandacht voor de wetenschappelijke onderbouwing groot en steeds weer werd die wetenschappelijke onderbouwing uitvoerig beschreven en benadrukt.

Elke verandering in de normen en in de beleidsmaatregelen die verbonden zijn aan overschrijding van de normen, heeft vergaande gevolgen. Het kan leiden tot maatschappelijke onrust, en als die veranderingen elkaar snel opvolgen kan het leiden tot afnemend vertrouwen in de normen en in het normstellingsproces als zodanig. Gezien de waarde die gehecht wordt aan de wetenschappelijke onderbouwing, staat ook het vertrouwen in de wetenschap op het spel. Toch ook kan aanpassing van de normen verwelkomd worden, bijvoorbeeld wanneer de actoren de bestaande normen als beperkend of te strikt beoordelen. Daarmee wordt duidelijk dat de acceptatie van en het vertrouwen in normen en normstelling van meerdere factoren afhangt. Er moet afstemming plaatsvinden tussen de hoogte van de norm, de beleidspraktijk en het wetenschappelijke onderzoek. In het proefschrift maak ik die afstemming zichtbaar en komt de betrokkenheid van wetenschap en beleid aan de orde. Daarmee is niet gezegd dat ik wetenschap en beleid als afzonderlijke domeinen opvat. Het onderscheid tussen wetenschap en beleid is niet eenduidig. Er is sprake van een normstellingspraktijk. Die praktijk wordt gekenmerkt door het gedeelde belang van wetenschap en beleid bij de vaststelling van normen.

De wetenschappelijke onderbouwing van normen bestaat doorgaans uit complexe modellen. Die zijn gebaseerd op resultaten van metingen van de concentraties van stoffen in de bodem en van experimenten waarbij organismen worden blootgesteld aan potentieel toxische stoffen. De personen die betrokken zijn bij besluitvorming over die wetenschappelijke onderbouwing hebben vaak een wetenschappelijke opleiding in een relevant vakgebied en hebben redelijk tot goed in zicht in die modellen. Dat geldt voor degenen die verbonden zijn aan een universiteit of onderzoeksinstituut, maar ook voor beleidsmakers. Omgekeerd zijn de betrokken medewerkers van universiteit of onderzoeksinstituut op hun beurt goed geïnformeerd over het beleid. In de besluitvorming worden beleidsmatige en wetenschappelijke argumenten voor de selectie van bruikbare kennis in samenhang gebruikt.

In het bovengaande is de nadruk gelegd op normen als representaties van een fysiek kenmerk van de bodem: het concentratieniveau van een stof in de bodem. Echter, de betekenis van die norm: 'schoon' of 'verontreinigd', is een sociaal construct. De kwalificaties, 'schoon' en 'verontreinigd' zijn gebaseerd op interpretaties van en waardeoordelen over de aanwezigheid van stoffen in de bodem. Ze liggen niet als zodanig besloten in die aanwezigheid van de stoffen in de bodem. De norm verwijst niet alleen maar naar een stofconcentratie. De norm verwijst ook naar de uitkomst van een sociaal proces, waarin 'schoon' en 'verontreinigd' betekenis krijgen. In het onderzoek naar normen spelen die twee representaties voortdurend met elkaar. Voor de bestudering van normen is het van belang beide representaties in de analyse te betrekken.

De veronderstelling dat de wetenschap alleen uitspraken doet over die fysieke kenmerken, de stofconcentratie, en dat beleid gaat over die sociale constructie is nog algemeen gangbaar. De resultaten van het onderzoek zoals beschreven in het proefschrift laten zien dat het van belang is die voorstelling van zaken waarin wetenschap de fysieke representatie voor haar rekening neemt, en zich niet inlaat met normatieve uitspraken en de classificatie van 'schoon' en 'verontreinigd' kritisch te bevragen. Als gezegd, wetenschap en beleid zijn beide betrokken bij de afleiding van normen en de selectie van de bruikbare, wetenschappelijke kennis. Ze doen dat beide deels vanuit een eigen en verschillend perspectief, maar met het gedeelde belang bij de vaststelling van de normen. In dit onderzoek behandel ik die samenwerking voor de totstandkoming van normen als co-productie. Die co-productie vindt plaats in een normstellingspraktijk. Een van de processen binnen die normstellingspraktijk is de selectie van bruikbare wetenschappelijke kennis. Welk model wordt gebruikt om de effecten van stoffen op ecosystemen en mensen te beschrijven en te voorspellen? Op basis van welke wetenschappelijke kennis wordt het niveau vastgesteld waarvan de risico's als acceptabel kunnen worden aangemerkt? Deze vragen raken aan de kern van milieubeleid en -management.

De aanpak van het onderzoek: twee concepten

Gegeven de implicaties van de overschrijding van de normen, is het relevant en wetenschappelijk interessant om dat proces van selectie van bruikbare wetenschappelijke kennis beter te begrijpen. Er zijn meerdere strategieën mogelijk om dat te doen. Ik heb dat gedaan door de afleiding van drie opeenvolgende normenstelsels te analyseren als cases binnen de context van het bodembeleid en -onderzoek in Nederland. Die drie cases en de context zijn zowel afzonderlijk alsook op hun samenhang geanalyseerd. Voor die analyse is een interpretatief kader gebruikt.

De twee belangrijkste concepten in dat interpretatief kader zijn **grenswerk** (boundary work) en **institutionele context** (institutional context). Het concept grenswerk werd voorgesteld door T.F. Gieryn in 1983. Het vestigt de aandacht op de begrenzing van wetenschap en beleid. Die grens kan gedemarkeerd of verplaatst en daarmee benadrukt worden, maar ook kan die grens vertroebeld worden en daarmee vervagen. Het actief werken aan het trekken dan wel vervagen van die grens wordt samengevat in die term grenswerk. De selectie van bruikbare kennis heb ik opgevat als grenswerk, waarbij ik het concept in haar beide betekenissen gebruik. De kracht van het concept is dat het vaak resulteert in herkenbare beschrijvingen van een case waarin de tegenstelling of samenwerking tussen wetenschap en beleid centraal staat. Het is dan ook een veelgebruikt concept in analyses van normstellingspraktijken. Echter, als instrument voor analyse vond ik het voor mijn onderzoek niet toereikend. Om die reden heb ik het interpretatief kader uitgebreid met een institutioneel perspectief: 'institutionele context'. Dit concept is gebaseerd op een review van institutionele benaderingen van W.R. Scott uit 1995. Het concept vestigt de aandacht op het multidimensionale karakter van institutionele contexten. Scott onderscheidt een regulatieve, cognitieve en normatieve dimensie, die in samenhang de institutionele context karakteriseren. De **regulatieve dimensie** omvat wet- en regelgeving. Toegepast op het onderwerp van het proefschrift vallen daaronder bijvoorbeeld de Interimwet Bodemsanering uit 1982 en de Wet Bodembescherming uit 1987. Later komt daar onder andere het Bouwstoffenbesluit bij. Doelmatigheid is een belangrijk uitgangspunt en handhaving en sanctionering zijn belangrijke mechanismen in die regulatieve dimensie. De tweede, **normatieve dimensie**, verwijst naar het spel en de spelregels die partijen hanteren om een bepaald doel te bereiken. Als voorbeeld noem ik hier de ontwikkeling in de relatie tussen de nationale en de gemeentelijke overheden. In het kader van de decentralisatie in het milieubeleid begin jaren negentig krijgt de gemeentelijk overheid meer bevoegdheden en verantwoordelijkheden. Parallel aan die ontwikkelingen neemt de invloed van industrie en maatschappelijke organisaties op de koers van het bodembeleid toe. De normatieve dimensie verwijst naar dergelijk ontwikkelingen. Tenslotte, de derde **cognitieve dimensie**. Die dimensie omvat de betekenissen die in het beleidsveld worden gegeven en de veranderingen daarin. Een voorbeeld daarvan is dat bodem in de jaren zeventig vooral werd gezien als productiefactor voor de landbouw, als ondergrond voor constructiewerken als bruggen en dijken, en als stortplaats voor huisafval. In de jaren tachtig veranderde die visie en werd bodem ook een beschermwaardig milieucomponent. Aan die laatste betekenisgeving heeft het begrip 'multifunctionaliteit van de bodem' een belangrijke impuls gegeven. Dat begrip hield in dat bodemkwaliteit ongeacht het actuele landgebruik van een zodanig goede kwaliteit moest zijn zodat het voor elke functie geschikt zou zijn.

Centrale vraagstelling

De centrale vraag van het onderzoek is als volgt geformuleerd.

Hoe is de selectie van bruikbare kennis voor de afleiding van bodemkwaliteitsnormen te begrijpen in termen van grenswerk door wetenschap en beleid en in termen van de institutionele context en haar relatie tot de normstellingspraktijk?

Deze centrale vraag is uiteengelegd in vijf onderzoeksvragen die in het empirische deel van het proefschrift worden behandeld.

1. *Hoe kan de institutionele context beschreven worden? (Hoofdstuk 4)*
2. *Welke kennis is geselecteerd als bruikbare kennis? (Hoofdstukken 5, 6, 7)*
3. *Welke argumenten worden gebruikt in de selectie van bruikbare kennis en hoe zijn die verbonden met de drie dimensies van de institutionele context? (Hoofdstuk 5, 6, 7)*
4. *Hoe ontwikkelt de normstellingspraktijk zich gedurende de onderzochte periode? (Hoofdstuk 8)*
5. *Hoe beïnvloeden de dimensies van de institutionele context de selectie van bruikbare kennis in de normstellingspraktijk?(Hoofdstuk 8)*

De drie dimensies zijn gebruikt om de context van het bodembeleid en onderzoek te beschrijven in Hoofdstuk 4. Dat hoofdstuk geeft een beknopte geschiedenis van het beleidsveld en van de ontwikkeling van wetenschappelijke kennis en stelt een indeling in drie episoden voor. Door insiders zal ongetwijfeld gewezen worden op ontbrekende perspectieven en verhalen en die zijn er vanuit het oogpunt van volledigheid ook beslist. Een tweede mogelijke reactie die zo'n selectieve geschiedschrijving oproept is dat ik die rijke geschiedenis probeer te vatten in drie dimensies en ook nog eens opdeel in drie episoden. Dat veronderstelt dat de drie dimensies goed en eenduidig van elkaar te onderscheiden zijn. Dat is beslist niet zo; de drie dimensies zijn nauw met elkaar verbonden. Het meest evident is dat voor de relatie tussen de cognitieve en de normatieve dimensie. Zo wordt de betekenisgeving (cognitieve dimensie) vastgesteld in een interactie tussen betrokkenen volgens bepaalde spelregels (normatieve dimensie). Zo bezien is het uiteenleggen van betekenis en het sociale proces waarin die betekenisgeving tot stand komt problematisch. Echter, de beschrijving van die context in mijn proefschrift heeft een specifiek doel. Het uitsorteren van die rijke historie heeft een meerwaarde voor het duiden van specifieke ontwikkelingen gedurende de onderzochte periode. De onderzochte periode; 1971-2000 is onderverdeeld in **drie episoden** en voor elke episode zijn de drie dimensies beschreven. Elke episode vormt de context voor een case.

In elke case is gezocht naar de argumenten die zijn gebruikt voor de selectie van de wetenschappelijke kennis waarmee de normen zijn afgeleid. Vervolgens is nagegaan in hoeverre die drie dimensies herkenbaar zijn in de argumentatie voor de selectie van bruikbare kennis. Zo werd de relatie tussen het proces van selectie van bruikbare kennis in de normstellingspraktijk en de institutionele context duidelijk.

Tijdens de **eerste episode** (1971-1988) worden de **referentiewaarden** als normen voor bodemkwaliteit afgeleid. De selectie van bruikbare wetenschappelijke kennis voor de vaststelling van die referentiewaarden staat centraal in de eerste case study. In de **tweede episode** (1989-1994) worden de **streef- en interventiewaarden** afgeleid; deze normen staan centraal in de tweede case study. In de **derde episode** (1995-2000) worden de **bodemgebruikswaarden** afgeleid, het normenstelsel dat in de derde case study is onderzocht.

Referentiewaarden in episode 1; 1971-1988

In de eerste case staat de selectie van bruikbare kennis voor afleiding van de referentiewaarden voor zware metalen centraal. Destijds, halverwege de jaren tachtig was de kennis over mogelijke toxische effecten van stoffen beperkt tot een inventarisatie van aanwezigheid van zware metalen in 'relatief onbelaste gebieden'. Daarmee werden natuurterreinen bedoeld, waar geen anthropogene toevoeging van zware metalen werd verwacht. Daar werd destijds mee bedoeld dat er in die gebieden geen stoffen werden toegevoerd door menselijk handelen. Met de toevoer van stoffen via lucht, regen of grondwaterstromen werd nog geen rekening gehouden. Er werd dan ook vanuit gegaan dat de concentraties die op die lokaties gemeten werden een achtergrond waarde was; een referentie voor schone grond. Zonder dat was aangetoond dat op die lokaties inderdaad geen antropogene toevoer had plaatsgevonden en dat er geen effecten waren op het ecosysteem werd dat dus wel verondersteld. Pas later werd duidelijk dat milieuverontreiniging voor een belangrijk deel afkomstig is uit atmosferische depositie en via grondwaterstroming; het milieuprobleem zure regen werd pas later geïdentificeerd. Deze bodemfysische en bodemchemische wetenschappelijke kennis werd als bruikbaar aangemerkt.

Normen werden in de jaren tachtig gezien als de belangrijkste instrumenten in het milieubeleid. Aangezien het bodembeschermingsbeleid toch al qua ontwikkeling van beleidsinstrumentarium achterliep op beschermingsbeleid voor water- en luchtkwaliteit, was de behoefte aan een normenstelsel voor bodemkwaliteit groot. Die normen zouden invulling moeten geven aan het principe van multifunctionaliteit, dat in de Wet Bodembescherming was vastgelegd als leidend principe voor bodembescherming. Het principe houdt in dat de kwaliteit van de bodem zodanig moet zijn dat de bodem geschikt is voor elke vorm van landgebruik. De kwaliteit van de bodem in die relatief onbelaste gebieden werd verondersteld te voldoen aan die voorwaarde van multifunctionaliteit. Zo werd onderbouwd dat de daar gemeten waarden gebruikt konden worden als normen voor goede bodemkwaliteit. Om vergelijkingen mogelijk te maken tussen de verschillende bodemtypen in Nederland (zand, veen, klei) werden de referentiewaarden gestandaardiseerd. Bodem van een bepaalde samenstelling (lutum en organisch stofgehalte) werd als standaardbodem aangemerkt. De referentiewaarde van 35 mg/kg droge grond voor koper had betrekking op die standaardgrond en kon met stofspecifieke correctieformule worden omgezet naar een concentratieniveau voor grond van elke andere samenstelling. De verwijzing naar de ontwikkeling van de wetgeving speelde in deze case een belangrijke rol.

Streef- en interventiewaarden in episode 2; 1989-1994

In de tweede case was het experimentele ecotoxicologische kennis die werd gebruikt voor de afleiding van een nieuw stelsels van normen: de streef- en interventiewaarden. Sinds de afleiding van de referentiewaarden in de jaren tachtig was de kennis over de effecten van blootstelling op organismen en ecosystemen sterk gegroeid. De opkomst van experimentele eco(toxico)logie vanaf de tweede helft van de jaren tachtig leidde tot een grote hoeveelheid gevens over effecten van stoffen. Daarmee konden dosis-respons relaties worden vastgesteld en kon de aanname die in de vorige case zo bepalend was, getoetst worden. In samenhang met de ontwikkeling van experimentele studies en het beschikbaar komen van grote hoeveelheden gegevens werden modellen en statistische technieken ontwikkeld voor de ordening en interpretatie van die gegevens. Met name extrapolatiemodellen en ecosysteemmodellen dateren uit die tijd. De ontwikkeling in de wetenschappelijke kennis speelde een belangrijke rol. Belangrijker was dat die kennis was ontwikkeld in afstemming met de beleidsvisie. Als aanhangsel bij het Nationaal Milieubeleidsplan uit 1989 werd door het Ministerie van VROM de brochure: Omgaan met risico's gepubliceerd. Daarmee werd de risicobenadering in het Nederlands milieubeleid geïntroduceerd en werd geargumenteerd dat milieueffecten van stoffen als zodanig onvermijdelijk waren. Het was zaak vast te stellen welke effecten acceptabel waren. Oftewel, welk risico was acceptabel? De vaststelling van dat risiconiveau moest wetenschappelijk onderbouwd worden.

Het beleidsdenken in termen van risico's en acceptatie van effecten sloot goed aan bij de verdere ontwikkeling van wetenschappelijke modellen waarmee voor afzonderlijke stoffen afgeleid kon worden welk percentage van soorten in een ecosysteem effect zou ondervinden van de aanwezigheid van die stof. Op basis van die modellen werd het acceptabel (maximaal toegestaan) risiconiveau afgeleid van de gemodelleerde concentratie waarbij 95% van de soorten geen als nadelige te waarderen effect zou ondervinden. Dit werd de streefwaarde. Een tweede norm, de interventiewaarde, werd uit dezelfde modellen afgeleid. Daarvoor werd het concentratieniveau gebruikt waarbij 50% van de soorten geen nadelig effect ondervond. De ontwikkeling van dit stelsel van streef- en interventiewaarden als uitwerking van de risicobenadering in het Nederlands milieubeleid is een goed voorbeeld van wat in de literatuur wordt geduid als 'co-productie'. Wetenschappelijke ontwikkelingen en beleidsontwikkelingen zijn daarin verweven en niet meer te duiden als simpele oorzaak-gevolg relaties. Behalve de verweving van wetenschap en beleid, levert de tweede case study ook een mooi voorbeeld op van het onderscheid tussen 'research science' en 'regulatory science'. Het is onjuist om die termen te vertalen met 'fundamenteel onderzoek' en 'toegepast onderzoek'. Het onderscheid tussen 'regulatory science' en 'research science' verwijst naar het complex van motieven van wetenschappers om hun expertise al dan niet, of onder bepaalde condities, af te stemmen met beleidsontwikkelingen die regulerend van aard zijn. De selectie van bruikbare kennis in de tweede case is (ook) te duiden als het demarkeren van 'regulatory science' en 'research science'. Het principe van multifunctionaliteit bleef onverminderd van kracht, waarmee er twee beleidsuitgangspunten naast elkaar bestonden, die sterk van elkaar verschilden in de mate van operationalisering. Het principe van multifunctionaliteit werd wel steeds luider bekritiseerd en in verband gebracht met de maar toenemende omvang van de bodemsaneringsoperatie en de trage voortgang in de sanering.

Bodemgebruikswaarden in episode 3; 1995-2000

In de derde case staat de selectie van bruikbare kennis voor de afleiding van de bodemgebruikswaarden centraal. Die bodemgebruikswaarden zijn afgeleid als onderdeel van een vernieuwing van het bodembeleid (BEVER). Het principe van multifunctionaliteit dat zo bepalend was geweest voor de ontwikkeling van het bodembeleid werd ten dele vervangen door een functiegerichte benadering van bodemkwaliteit en saneringen. Landgebruik werd daarmee bepalend voor de bodemkwaliteit ter plekke. Voor de ontwikkeling van die bodemgebruikswaarden was het allereerst nodig een classificatie te maken van landgebruik. Daarbij werd gebruik gemaakt van classificaties uit de ruimtelijke ordening. Voor elk type landgebruik werden bijbehorende normen afgeleid; de bodemgebruikswaarden. De bodemgebruikswaarden geven aan wat de minimaal vereiste bodemkwaliteit is voor dat landgebruik. Wanneer die minimale bodemkwaliteit niet wordt gehaald moet de bodemkwaliteit verbeterd worden. Dat kan bijvoorbeeld door te saneren, maar ook door een zogenaamde leeflaag aan te brengen. Dat is een laag grond die aan die minimale kwaliteit voldoet. Vergeleken met de referentiewaarden en de streefwaarden, zijn de bodemgebruikswaarden geen indicatoren voor 'schoon' maar voor een minimaal vereiste bodemkwaliteit behorend bij een specifiek landgebruik.

De ontwikkeling van deze functiegerichte benadering kwam voort uit de kritiek op het bodembeleid tot dan toe. Die kritiek werd met name door de gemeentelijk en provinciale overheden en het bedrijfsleven geuit. De kern van die kritiek was dat het bodembeleid en de bodemkwaliteitsnormen niet goed waren afgestemd op de praktijk en dat ze te streng waren. Ook vanuit de nationale overheid werd aangedrongen op versnelling van de bodemsaneringsoperatie. De hoeveelheid lokaties waar gesaneerd moest worden en de daarmee gemoeide kosten waren niet langer op te brengen. Er moest een meer pragmatische en praktijkgerichte koers worden gevaren en die werd gevonden in de functiegerichte benadering. Daarmee raakte het bodembeleid in de eerste helft van de jaren negentig verder verweven met het ruimtelijke ordeningsbeleid, en met het natuur- en landbouwbeleid. Daarmee samenhangend ontwikkelde de betekenis van bodem zich van beschermwaardig milieucompartiment in de richting van een economisch te waarderen goed. De als bruikbaar geselecteerde wetenschappelijke kennis bestond uit een verzameling van inzichten en modellen afkomstig uit milieu-, landbouw- en ruimtelijke ordeningsbeleid.

De selectie van bruikbare kennis in de normstellingspraktijk

De case studies hebben laten zien dat de argumentatie voor de selectie van bruikbare kennis verbonden is met de institutionele context. De argumentatie heeft niet alleen betrekking op de wetenschappelijke kwaliteit van de betreffende kennis. In de eerste case was de voortgang van het bodembeleid en de wet- en regelgeving een cruciale factor in het proces van selectie. Uit de case study kan geconcludeerd worden dat de regulatieve dimensie in die eerste episode van doorslaggevende betekenis is geweest. Uit de tweede case study kan geconcludeerd worden dat de cognitieve dimensie belangrijker wordt. De ontwikkeling van de risicobenadering en de ontwikkeling van wetenschappelijke kennis versterken elkaar. Dat leidt er toe dat die kennis die het meest nauw verweven is met de risicobenadering, wordt geselecteerd als bruikbaar. Uit de derde case study kan geconcludeerd worden dat de bodemgebruikswaarden onderdeel zijn van de ontwikkelingen in de relatie tussen partijen. Daarmee is gezegd dat uit de derde case study de normatieve dimensie naar voren komt als bepalend voor de selectie van bruikbare kennis.

De kwantitatieve voorstelling van normen voor bodemkwaliteit wekt de suggestie dat de concentratiegrenzen gebaseerd zijn op wetenschappelijk zekere kennis en op overeenstemming daarover. Dat is eigen aan kwantitatieve representaties. Het onderzoek beschreven in dit proefschrift laat zien dat wetenschappelijke kennis over effecten van stoffen op ecosystemen is omgeven met grote onzekerheden van uiteenlopende aard. Mijn proefschrift sluit daarmee aan bij onderzoek dat pleit voor een explicitering van de onzekerheden waarmee wetenschappelijke kennis over effecten van stoffen op mens en ecosystemen is omgeven. De huidige representatie van stofnormen verdient een heroverweging. Een tweede belangrijke reden voor een heroverweging is dat het vertrouwen in wetenschappelijke expertise ermee gebaat zou zijn. Een meer reflexieve houding, waarbij het onzekere karakter en de dissensus over bepaalde wetenschappelijke kennis wordt geëxpliciteerd, draagt bij aan behoud en versterking van de legitimiteit van wetenschappelijke kennis als onderbouwing voor beleidsmaatregelen.

Reflectie op het interpretatief kader

Het concept 'grenswerk' diende als uitgangspunt voor het interpretatief kader en werd aangevuld met het concept 'institutionele context'. Het onderscheiden van de normatieve, regulatieve en cognitieve dimensie wekt de suggestie dat dat onderscheid in het empirisch materiaal zichtbaar of aanwijsbaar is. Dat is natuurlijk niet zo! De onderzoeker maakt dat onderscheid en sorteert het empirisch materiaal uit. Ook al worden dergelijk essentialistisch benaderingen graag bekritiseerd, opvallend is hoe veel ze, ook door die onderzoekers, gebruikt worden. Een goede essentialistische benadering dwingt de onderzoeker om te beargumenteren waarom het empirisch materiaal zo kan worden uitgesorteerd en verrijkt daarmee het inzicht. Op basis van mijn ervaringen met het concept van Scott kwalificeert het (nog) niet als zodanig. De omschrijving van de dimensies is daarvoor nog onvoldoende uitgewerkt. Daarmee blijven er voor de onderzoeker teveel vrijheidsgraden voor het uitsorteren van dat empirisch materiaal.

De twee concepten 'grenswerk' en' institutionele context' verschillen in meerdere opzichten. Die verschillen zijn terug te voeren op hun epistemologische uitgangspunt. Institutionele concepten richten het zoeklicht op stabilisering en dynamiek. Het werken met een institutioneel concept maakt grotere patronen en stabilisering zichtbaar. Daarmee was het een geschikte benadering om de grotere lijnen in de periode van 1971 tot 2000 te duiden. Voor het inzoomen op onderdelen van die grotere lijnen is een institutioneel concept minder geschikt. Dan verdwijnt de veronderstelde stabiliteit, en wordt de dynamiek zichtbaar. Het concept 'grenswerk' heeft een bijna tegenovergestelde uitwerking. Dat concept benadrukt activeit, dynamiek en verandering. Voor de contextuele analyse in dit proefschrift, waarbij cases in hun context werden geplaatst werkte de combinatie van deze twee benaderingen goed. In de analyse van de context werd gezocht naar stabiliteit, terwijl in de case studies gezocht werd naar de dynamiek in de normstellingspraktijk. Zo kon het verschil in epistemologische uitgangspunten juist benut worden om het inzicht te vergroten, en werden de beide concepten verenigbaar.

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Astrid F.M.M. Souren, Augustus 2006, Nijmegen

Curriculum vitae

Astrid Souren werd geboren op 18 maart 1967 te Schimmert. Na het behalen van het VWO-B diploma in 1986 aan het Stella Maris college te Meerssen, volgde zij de studie Biologie aan de Universiteit Utrecht. Tijdens de studie waren ontwikkelingssamenwerking, onderwijsontwikkeling, plantenecologie en ecofysiologie de kernthema's. Het doctoraalexamen werd behaald in augustus 1994. Aansluitend volgde in 1994 en 1995 een gastmedewerkerschap aan de Faculteit Biologie (UU) en werd een haalbaarheidsstudie uitgevoerd naar de opzet van traineeships binnen de Faculteit Biologie (de voorloper van wat later de Communicatieve en Maatschappelijke Afstudeervariant werden in het bètaconvenant). In diezelfde periode heeft zij een samenwerkingsverband tussen de Universiteit Utrecht, IUCN-Uganda, en Makarere University in Uganda onderzocht over de duurzame exploitatie van bamboe uit Mount Elgon NP, Uganda. Als consultant voor de Stichting AidEnvironment te Amsterdam werden in 1995 en 1996 diverse projecten uitgevoerd voor de RMNO (Raad voor Ruimtelijk, Milieu en Natuuronderzoek), waaronder het rapporteurschap voor de commissie die het NWO Stimuleringsprogramma Systeemgericht Ecotoxicologisch Onderzoek (SSEO) voorbereidde. In 1996 en 1997 volgde een aanstelling als trainee aan de Universiteit Utrecht, Faculteit Biologie, gedetacheerd aan het (toenmalig) Staring Instituut (inmiddels onderdeel van Alterra) te Wageningen. Daar heeft zij als projectleider het pilotproject '*Assessing the role of natural vegetation in inland valleys in West Africa*' uitgevoerd voor het Inland Valley Consortium in Ghana. Van 1997-2003 volgde een aanstelling als AIO aan de Afdeling Algemene Vorming, Faculteit Exacte Wetenschappen van de Vrije Universiteit Amsterdam en werd het onderzoek uitgevoerd dat heeft geresulteerd in dit proefschrift. In 2001 werd de aanstelling tussentijds overgenomen door de Faculteit Biologie van de VU en volgde een detachering naar de Leerstoelgroep Milieu en Beleid van de Faculteit Managementwetenschappen, Radboud Universiteit Nijmegen.

Sinds April 2004 werkt Astrid Souren als Universitair Docent Wetenschapscommunicatie aan het Institute for Science, Innovation and Society (ISIS) van de Faculteit Natuurwetenschappen, Wiskunde en Informatica, Radboud Universiteit Nijmegen. Onderzoek, onderwijs en curriculumontwikkeling zijn geconcentreerd rond wetenschapscommunicatie, multi-, inter en trandisciplinariteit, kennissamenleving, en risico- en onzekerheidscommunicatie. Het onderwijs is onderdeel van de Facultaire Afstudeervariant Wetenschapscommunicatie. Het onderzoek is ingebed in de ISIS werkgroep Knowledge Society.